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The Mining Magazine

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EDITORIAL

AS a contribution towards the search for oil in Australia the Bureau of Mineral Resources of the Department of National Development is to go ahead with a programme of shallow stratigraphical drilling at selected locations in the sub-continent. In all, it is stated, five holes are to be drilled and cored, the programme to commence as soon as roads are passable at the conclusion of the current wet season. The first of the holes is to be put down at Wallal on the southern edge of the Canning Basin and the second at Giralia in the Exmouth Gulf area, the remainder to be located at Muderong, in the Carnarvon Basin. The work is to be done by Oil Drilling and Exploration, Ltd., to whom a contract has been awarded after calling of public tenders.

Geological Researches in Russia

Although it has long been known that the study of geology and mineral resources plays a much bigger rôle in Russian science than in the researches of western nations little information has hitherto been available on the precise magnitude of this Soviet effort. Special interest therefore attaches to a detailed report [1] by Dr. Pierre Laffitte, Director of the Bureau de Recherches Géoligiques, Géophysiques, et Minières in Paris, who has lately returned from a mission to Moscow and Leningrad.

According to this review Russia's expenditure on geology and mineral exploration is of the order of 12 milliard roubles or roughly £1,000,000,000 annually. Geological investigations are conducted by various Ministries of State and by the Academy of Sciences. The Ministry of Geology, engaged exclusively in geological mapping, prospecting, and ancillary studies has an annual budget of around £300,000,000 and a total staff (mainly non-professional) of 200,000. The Ministries of Petroleum, Coal, and Non-Ferrous Metals respectively spend £250,000,000, £170,000,000, and £170,000,000 in comparable work and several other Government Departments maintain large geological services. Dr. Laffitte finds it less easy to assess the large expenditure on geological research by the Academy of Sciences of the U.S.S.R. and by the Geological Institutes attached to the Academies in the Ukraine, Georgia, Kazakhstan, and Uzbekistan. He estimates the number of professional geologists within the Soviet Union at 20,000, of whom 12,000 are employed by the Ministry of Geology. Mapping on a scale of 1 : 1,000,000 has been completed and 43% of the U.S.S.R. is now covered by geological maps on a scale of 1 : 200,000. An important feature of this reconnaissance mapping is the emphasis placed on geochemical prospecting.

Particular attention was paid by Dr. Laffitte to the educational system whereby the geologists were produced, as seen at the School of Mines in Leningrad (5,000 students), the Geological-Prospecting Institute in Moscow (1,500 students), and the University of Moscow. Students enter these institutions after 10 years of schooling and their higher studies have a duration of five years. Holidays are limited to four weeks each autumn and two at Christmas, but within the third and fourth university years 21 weeks are spent as trainee assistants with field parties of the Ministry of Geology or like institutions, while in the fifth year 17 weeks are spent on a research problem. The general range of studies seems to be wider than in Western Europe and America, with more attention paid to geophysics, geochemistry, and economic geology. An outstanding student may proceed as an " aspirant " to three years of post-graduate study, akin to a British Ph.D. course, becoming a " candidate of science." The appellation " doctor " is restricted to senior workers of special distinction.

The gap between teaching and fundamental research is much wider than in the west, most pioneer work being undertaken in the research institutes (principally branches of the Academy of Sciences) rather than in the universities. Of research establishments in Moscow the Institute of Geology houses 200 specialists, the Institute of Petrography, Mineralogy, and Geochemistry has a staff of 700, including 400 scientists, and the Institute of Geophysics comprises some 13 different divisions. In Leningrad the famous Institute of Geology has a research staff of 1,600, of which 40 are professors or " doctors," 200 are " candidates of science," and the remainder mainly " aspirants." The various different departments here include divisions of geological cartography, hydrogeology, mineralogy and geochemistry, geology of coal,

[1] " Géologie et Recherche Minière en Union Soviétique." *Ann. Mines*, Dec., 1957.

geomorphology, geology of ore deposits, Quaternary geology and glaciation, palaeontology and stratigraphy, and regional geology, sub-divided into Siberian, Far Eastern, West Uralian, and Western groups.

The authorities responsible for the development and maintenance of geological research in the British Dominions and Colonies and in the United States of America would do well to ponder over this report. It is currently rumoured that, following the success of uranium explorations, some of the larger geological surveys may soon find their establishments curtailed. The rapidity with which Russia is overtaking the West in all fundamental fields of earth science suggests that an expansion of geological services would be much more in the national interests.

Tin Research

Concurrently with the efforts of the International Tin Council to stabilize tin prices by bringing current output down to the decreased consumer demand it is as well to be reminded of the constant endeavour of the Tin Research Institute to widen the uses of the metal. The report on the work of the Institute during 1957 [1] has recently become available and it indicates that all departments were actively engaged in the development of new ideas and applications, not only for the metal but for analytical purposes also. It can be noted, for example, that the Chemistry Department at the Institute has been actively engaged in investigating the direct determination of tin in refined tin ingots. This matter is, as is well known, " somewhat controversial," but that a direct tin determination is possible has been established provided that the analyst has the experience. Impurities in tin ingots and solders have also been determined with a view to obtaining tin contents by difference and photometric methods put forward have been used successfully and are likely to be incorporated in a standard specification.

The Institute draws attention to the publication of a method of producing electroplated deposits of tin in a fully bright form.[2] Formerly the tin deposit obtainable by electroplating was matte and chalky in appearance, but the new method, it is claimed, produces coatings which come from the bath with the appearance of having been mechanically polished. At the same time the Institute's invention of a method of bonding aluminium-tin bearing alloys to steel, referred to in the last issue of the MAGAZINE, has now reached the commercial stage of development and thousands of cars, it is stated, have already been fitted with the new type of bearings. Again while tin as an impurity in cast iron has always been frowned upon recent work at the Battelle Memorial Institute has shown that small amounts of tin may bring about desirable structural changes without detriment to mechanical properties.

Some time ago [1] attention was drawn here to the rapidly-growing uses of organotin compounds, particularly as fungicides, and according to the report now available it would appear that these are now proving of use agriculturally. It is stated that a leading chemical firm in Germany has marketed the first organotin fungicide for farmers' use and research is going on at the Institute to find improved methods of analysis. In addition a large number of compounds known to form complexes with tin or other metals is being tested in the attempt to find one which will permit the determination of both types of organotin compound in a mixture without a preliminary separation. This interest in organotin compounds has been considerably increased during the year through the conferences organized by the International Tin Council in Milan and Frankfurt.

[1] Greenford, Middx. : Tin Research Institute.
[2] *Trans. Inst. Metal Finishing*, 1957, **34.**

Cornish Clay and Stone

China-clay and stone working in Cornwall is traceable back to the discovery at Tregoning Hill of a rich china stone almost 200 years ago by William Cookworthy, a friend of Captain Cook and Sir Joseph Banks. Cookworthy was a Quaker pharmacist interested in porcelain making and his searches of the literature led him to recognize Cornwall as a source of two indispensable raw materials. In some " Letters from China " written by the Jesuit father D'Entrecolles, who had spent years at the porcelain centre of Ching-tê-Chên, Cookworthy noted how the Chinese had two sorts of bodies for porcelain—one prepared with " petunse " and " caulin " and the other with petunse and " Wha She " or " soapy rock." Petunse, he noted, was

[1] THE MINING MAGAZINE, Nov., 1956, p. 260.

prepared from a quarry stone " by beating it in stamping-mills and washing off and settling the parts which are beaten fine. This ingredient gives the ware transparency and mellowness and is used for glazing it."

It was this recognition of essential raw materials which sent Cookworthy to scour Cornwall and neighbouring Devon for two minerals. He told how Chinese petunse was a species of granite " or, as it is called in the West, the Moorstone." " I first discovered it in the parish of Germo, in a hill," he said. " The stone is a pellucid gravel plus a whitish matter which is called Caulin petrified and is stained with green spots as the Jesuit noted." Cookworthy also told how " there was an inexhaustible store in the West, a common use being to mend the tin furnaces and the fire-places of fire-engines." Later he was to discover, in the parish of St. Stephens between Truro and St. Austell, large deposits of both his " caulin " and " petunse." He fully appreciated how caulin, or kaolin, for opaque porcelain, or the " bones of china," and petunse, or china stone, as a vitrifiable material to give firmness and transparency (hence it was the " flesh of china " to the Chinese), were invaluable minerals which one day would bring prosperity to Cornish mining. His " fusible china-stone or growan stone " he first noted used in the tower of St. Columb church, for it was only later he found it in quantity at St. Austell.

This Plymouth apothecary was not to benefit much from his foresight, for he missed financial gain from developing his Cornish china-clay when he sold a porcelain patent to Richard Champion, of a Bristol porcelain works. Bristol as a centre had a short life, incidentally, yet by transferring to Worcester, which has its flourishing Royal Porcelain Works to-day, the industry foreseen by Cookworthy has survived in the two centuries since his Cornish rhapsody. " A tall venerable man in a three-cornered hat and bushy curly wig " is the description given by biographers or the few writers who recognized Cookworthy's wide interests. More to the point was the line on his being " constantly so very eager in acquiring knowledge, that he could seldom find leisure to communicate to others his store of information." Before he found china clay in Cornwall it had to be imported from Virginia and Carolina. This trade was reversed on a large scale when some hundreds of thousands of tons were exported from such little ports as Fowey and Par to the United States, before Georgia and North Carolina developed their own china-clay resources. Although kaolin is unknown on any great scale elsewhere in Britain the known deposits seem likely to sustain the outcome of Cookworthy's persistence in 1758.

Copper in 1957

Figures relating to world production and consumption of copper in 1957 were recently released by the British Bureau of Non-Ferrous Metal Statistics. These show that the " free world " production of new blister metal in that year totalled some 2,960,000 tons, 28,000 tons more than in the previous year, although the output of refined copper at 3,441,000 tons was 14,000 tons less for the same period. Smelter production fell by 44,000 tons in the U.S.A. and by 9,000 tons in Chile and 7,000 in the Belgian Congo, but there were increases of 32,000 tons in Northern Rhodesia, 3,000 tons in Canada, and 13,000 tons in Japan. These six countries accounted for 87% of free world smelter production during the year (86% 1956). The output of refined copper included some 500,000 tons recovered from secondary material, the overall decline in total output compared with the increase in smelter production being due mainly to an increase in stocks of blister awaiting refining.

In the year under review the consumption of copper is estimated to have fallen by 13,000 tons to approximately 3,263,000 tons, production exceeding consumption by some 200,000 tons, of which a net 60,000 tons is believed to have gone into Government stockpiles. Visible world stocks of blister and refined copper rose by 149,000 tons and totalled 995,000 tons at the end of 1957, excluding stocks held by all governmental agencies and by consumers in many European and South American countries. The decline in world consumption, it is suggested, was due mainly to the United States and Canada, where consumption fell by 153,000 tons and 25,000 tons respectively. Consumption rose 6,000 tons in the United Kingdom and there were increases in most other European countries, with the result that consumption in Western Europe reached a record of 1,549,000 tons, although there were some signs of falling off towards the end of the year. Japanese consumption was 29,000 tons higher than in 1956, mainly due to high rates in the early part of the year.

MONTHLY REVIEW

Introduction.—Over the past month the fall in commodity prices has, in general, continued; all base metals have remained dull with, of course, tin excepted, since this metal is well supported by the International Tin Agreement. While it is certain that demand will in time rapidly grow again the business world is at present taking careful stock and there seems little likelihood of change in the near future.

Transvaal.—The South African mines in January produced a total of 1,418,039 oz. of gold, a new record, 1,377,505 oz. coming from companies members of the Chamber of Mines and 40,534 oz. from outside sources. In February the Rand mines produced 1,322,843 oz. and outside mines 33,879 oz., making 1,356,722 oz. for the month. At the end of February there were 326,885 natives employed in the gold mines, as compared with 314,239 at January 31.

The report of the MESSINA (TRANSVAAL) DEVELOPMENT COMPANY for the year to September 30 last shows a profit of £1,159,674 and £1,603,680 available, of which dividends equal to 220% required £726,000. In the year 915,010 tons of ore was treated and 31,835 tons of concentrates recovered, while the smelter output amounted to 14,723 long tons of copper. The report says that despite the production of nearly 916,000 tons of ore during the past year the tonnage of ore reserves remained practically unchanged at 5,292,350 long tons with a slight reduction in average values from 1·82% Cu to 1·79%.

The consolidated accounts of the RAND SELECTION CORPORATION for the year ended September 30 last show a profit of £1,150,730 and £1,445,699 available, of which dividends totalling 2s. 6d. a share require £937,000.

The SOUTH AFRICAN TOWNSHIPS MINING AND FINANCE CORPORATION reports a profit of £229,694 for the year to September 30 last, the accounts showing £242,553 available, of which a dividend equal to 6d. a share requires £120,000.

The report of the CONSOLIDATED MINES SELECTION COMPANY for 1957 shows a profit of £193,602 and a total of £271,863 available for appropriation. Dividends equal to 2s. 6d. a stock unit require £135,843. At the annual meeting to be held later this month resolutions are to be submitted providing for the capitalization of £47,250, forming part of the capital reserve, and for the issue (in the proportion of one new share for every 20 stock units of 10s. held) of 94,500 fully-paid ordinary shares of 10s. each. The consent of H.M. Treasury has been received to the proposed issue it is stated.

In the year to September 30 last NIGEL VAN RYN REEFS made a profit of £28,786, making with the sum brought in an available total of £42,973. A dividend equal to 4½d. a share requires £12,208 of this amount and after transferring £17,900 to reserve a balance of £12,865 is carried forward.

Southern Rhodesia.—The operations of FALCON MINES in the year ended September 30 last resulted in a profit of £103,685, the accounts showing £119,649 available, of which dividends equal to 17½% required £79,433. At the Dalny mine 190,800 tons of ore was treated and 33,208 oz. of gold recovered, while at the Sunace 21,930 tons yielded 5,370 oz. and 15,880 tons at the Bay Horse 3,063 oz. As noted a year ago it has been decided to increase the capacity of the reduction plant at Dalny from about 15,000 tons to 20,000 tons per month and to introduce certain modifications and additions designed to improve the gold extraction. The report says there were some delays in the delivery of the new plant units and the extensions to the mill were not completed until about the end of the year under review. Since the units were commissioned at the beginning of October, 1957, both mechanical and metallurgical difficulties have been experienced but these teething troubles are being overcome.

The report of M.T.D. (MANGULA) for the year to September 30 last says that by the end of the year the installation of one Aerofall mill had been completed, enabling the production and sale of copper concentrates to be started. The ore reserves at September 30, 1957, were 25,881,000 short tons assaying 1·36% copper, as compared with 17,920,000 short tons (16,000,000 long tons) assaying 1·6% indicated at the end of the previous year. Railage of concentrates

from the mine for shipment overseas commenced in October.

Northern Rhodesia.—A circular to shareholders of RHODESIAN ANGLO AMERICAN issued last month stated that to meet capital requirements it has been decided to raise additional funds by the issue of £4,000,000 (Federation of Rhodesia and Nyasaland currency) 6% registered loan stock at £95%. Subscribers of the loan stock are to receive options exercisable up to and including March 31, 1963, to subscribe for the 1,000,000 reserve shares in the capital of the company at 80s. per share payable either in cash or by the surrender of loan stock. The major portion of these funds is required for BANCROFT MINES, LTD., but in addition the issue will enable the company to assist in the provision of finance for the ANGLO AMERICAN RHODESIAN DEVELOPMENT CORPORATION, which has large commitments for the provision of trucks to the Rhodesia Railways and for the RHODESIAN IRON AND STEEL COMPANY and also for prospecting ventures in the Federation of Rhodesia and Nyasaland.

Gold Coast.—The report of the ASHANTI GOLDFIELDS CORPORATION for the year to September 30 last shows a profit of £1,349,657 and a total of £1,681,503 available. After providing for taxation and other items £403,830 is required for dividends, equal to 1s. 10d. a share, leaving £382,569 to be carried forward. The mill treated 338,727 tons of ore at an average grade of 18·24 dwt., the yield being 275,217 fine oz., the highest ever reached in the history of the mine. The ore reserves at September 30, 1957, were 1,449,984 tons, of an average grade of 19·1 dwt. a decrease in tonnage of 419,731 but an increase in grade of 1·5 dwt. It is expected that the corporation will qualify as an Overseas Trade Corporation as from April 6, 1957, and it is probable that a substantial part of the provision for taxation in the 1956 accounts will not be required.

BIBIANI (1927) reports a profit of £104,739 for the year ended September 30, 1957, the accounts showing £331,193 available, of which dividends equal to 4·8d. per stock unit require £28,750. In the year the mill treated 371,843 tons of ore for a recovery of 77,992 oz. of gold. The ore reserves at September 30, 1957, were 1,335,539 tons at an average grade of 5·04 dwt. per ton, a decrease of 56,467 tons and 0·45 dwt. as compared with the previous year. It is expected that the company will qualify as an Overseas Trade Corporation as from April 6, 1957. The notice of the meeting for April 2 includes a proposed resolution to re-convert the issued capital of the company from stock transferable in 4s. units to un-numbered shares of 4s. each, a step considered to be administratively advantageous.

The accounts of ARISTON GOLD MINES (1929) for the year ended September 30, 1957, show a profit of £244,167 after taxation and £326,699 available, of which dividends totalling 3d. a unit require £64,688. In the course of the year 470,520 tons of ore of an average grade of 6·806 dwt. were milled against 327,050 tons of 6·313 dwt. average grade for the previous year, while 894 oz. of gold was produced from the special treatment of slags. The total bullion revenue for the year was £1,831,950, against £1,132,920 for 1956. The ore reserves at September 30 last were computed at 2,662,338 tons of an average value of 6·84 dwt., an increase of 100,040 tons and of 0·27 dwt. in the average value as compared with the preceding year.

In the year to June 30, 1957, GHANA MAIN REEF made a profit of £77,846, the accounts showing £78,733 available. After deducting the debit balance brought in and making other allowances a credit balance of £61,362 is carried forward. The ore reserves available at the end of the year are given as 371,201 tons averaging 849 dwt. in value over 77 in. In the year under review the 142,395 tons of ore treated yielded 47,568 oz. of gold.

KONONGO GOLD MINES reports a profit of £210,945 for the year ended September 30 last, dividends equal to 8d. a share requiring £134,241 of the £326,563 available. During the year 47,456 oz. of gold was recovered from 59,290 tons of ore milled. The report says that at Boabedroo the existence of a new block of ore between Nos. 8 and 10 levels to the south of the main ore-shoot was confirmed, but this block does not extend below No. 10 level. Development in depth from the No. 15 main winze on Nos. 16 and 17 levels was generally discouraging. The proved ore reserves at September 30 last were estimated at 189,410 tons averaging 14·5 dwt. per ton over an average width of 66 in.

In a summarized report covering the three months to December 31 last shareholders of BREMANG GOLD DREDGING are informed that progress on the scheme for the ultimate transfer of No. 3 dredge from the Ankobra River to the Offin is "generally up to schedule."

The report of AKIM CONCESSIONS for the

year ended September 30 last shows a profit of £5,474 and a credit of £5,277 available. Throughout the year, it is stated, operations continued in the Sensenkwakwa Valley. Progress was satisfactory and, compared with the previous year, a larger quantity of gravel was mined and milled, but the total production of diamonds was slightly less because a lower grade of gravel was treated. Illicit mining continues to handicap diamond mining in Ghana, the report says, and the company is taking every precaution to check this activity.

With the recent dividend notice shareholders of FANTI CONSOLIDATED INVESTMENT were informed that the profit for 1957 was £69,482, after allowing £105,191 for taxation.

Nigeria.—Last month shareholders of NARAGUTA EXTENDED AREAS were informed that the directors had received an intimation from the BISICHI TIN CO. (NIGERIA), LTD., to the effect that they are prepared to purchase the whole of the issued share capital of Naraguta Extended. Negotiations are proceeding, it was stated, and shareholders are to be advised of the outcome in due course.

Tanganyika.—In the three months to December 31 last ALAMASI, LTD., it is reported, treated 50,570 loads of ground and recovered 4,220 carats of diamonds.

Australia.—It was announced early this month that the WESTERN MINING CORPORATION has obtained a reservation of approximately 2,000 sq. miles in the West Kimberley district of Western Australia. The area covers an extensive copper mineralization which outcrops in various places over a distance of about 30 miles. The showings, it is stated, are some 60 miles from Derby to south of Collier Bay.

LAKE VIEW AND STAR reports that in the period from October 2, 1957, to December 24 development totalled 5,979 ft., of which 3,927 ft. was driven to develop the various lode channels, 2,238·5 ft., or 57·0%, being in ore averaging 6·1 dwt. per ton over a width of 56 in.

Last month INTERSTATE OIL, LTD., was advised by the ZINC CORPORATION that authority to prospect No. 35P, covering an area of the Great Barrier Reef, Queensland, had been surrendered, as investigations had not revealed prospects of oil or gas sufficiently encouraging to warrant a continuation of this work. The option granted to Interstate Oil to acquire an interest in the area has lapsed therefore.

Malaya.—PETALING TIN reports a profit of £22,674 for the year ended October 31, 1957, the accounts showing £115,588 available and carried forward. In the year 8,278,800 cu. yd. of ground was treated and 1,129 tons of tin ore recovered. The report says that during the current year No. 3 dredge will continue re-dredging the selected portion of the Sublease Area while No. 4 will follow a course further south in the same area after crossing the present river channel. Improved returns are expected from No. 6 dredge when it again enters virgin ground in April or May and turns to the north from its present south-westerly course.

Burma.—The accounts of the CONSOLIDATED TIN MINES OF BURMA for the fifteen months ended June 30 last show a profit of £7,884 and a credit balance of £46,679 carried forward. In the period 555 tons of mixed concentrates was obtained by tribute from the company's mines.

Brazil.—It was announced last month that the HANNA COAL AND ORE CORPORATION, together with Mr. Leo Model and associates, had acquired control of the ST. JOHN D'EL REY MINING COMPANY. Subsequently the M. A. HANNA CO., of Cleveland, Ohio, stated that St. John d'el Rey has what is believed to be the largest single holding of high-grade iron-ore reserves in Brazil. The properties comprise a tract of over 100 sq. miles, about 200 air miles north of Rio de Janeiro. Plans have been made to send to Brazil immediately a capable organization from the United States, fully equipped with large-scale prospecting and drilling equipment, to investigate the gold properties, to explore fully the iron-ore reserves, and to make detailed studies of the transport of iron ore and of dock facilities.

United States.—In a review issued earlier this month shareholders of CAMP BIRD, LTD., are informed that in view of the uncertain outlook for base metals the installation of a mill at the Camp Bird mine in Colorado has been deferred. In the course of development recent assays in one section have shown extremely high gold values. A new mining company, CAMP BIRD MINES, LTD., has been registered in London while, in the United States, a new company, CAMP BIRD COLORADO INC., is being formed to take over ownership and management of the Camp Bird mine properties in that State. Camp Bird Colorado will be a wholly-owned subsidiary of Camp Bird Mine.

Canada.—ALUMINIUM, LTD., reports a preliminary figure of $41,400,000, or $1·37 per share, as its net income for 1957, as compared with $55,600,000, or $1·85 per share, for 1956, this after giving effect to the 3-for-1 sub-division of shares.

The QUEMONT MINING CORPORATION reports that 837,231 tons of ore was milled in 1957, the estimated profit, after providing for depreciation and taxation, amounting to $1,498,000. Earnings during the year were seriously affected by the precipitous decrease in prices for copper and zinc, the high rate of discount on the U.S. dollar, and increased marketing and mine-operating costs.

In a recent circular shareholders of WESTERN SELECTION AND DEVELOPMENT were informed that CORDOBA MINES, LTD., has reported encouraging gold values encountered in recent drilling work. The company's consulting geologist has recommended a magnetometer survey, which is in progress. After the completion of magnetometer studies over an area of approximately 10 square miles a vigorous programme of trenching, bulldozing, and drilling is to be carried out as soon as climatic conditions permit.

Anglo-French Exploration Company.—The report of the Anglo-French Exploration Company for 1957 shows a profit of £50,014, making with the sum brought in an available total of £56,527, of which a dividend equal to 1s. 10 d. a stock unit requires £48,516. It has been decided to offer members the 100,000 ordinary shares at present unissued at par. The shares are to be offered in the proportion of one new share for every £9 ordinary stock at present held.

British South Africa Company.—The accounts of the British South Africa Company for the year to September 30 last show a consolidated profit of £4,830,496 and £6,894,513 available, of which dividends totalling 4s. 6d. a share require £2,266,780. The directors recently announced that they had been advised that, subject to their taking certain steps, the company's mining and estate interests in Rhodesia should qualify for the benefits accorded to an Overseas Trading Corporation under the Finance Act, 1957. The company's mining revenue from royalties or other sources during the year, after providing for the Northern Rhodesian Government's interest in that revenue, was £8,758,252, which was £3,504,657 less than the total for the previous year.

DIVIDENDS DECLARED

* Interim. † Final.

(Less Tax unless otherwise stated.)

†**Akim Concessions.**—Def. 8⅓%, Ord. 13%, payable Mar. 27.
†**Anglo-French Exploration Co.**—1s. 10½d., payable Apr. 2.
†**Ariston Gold Mines (1929).**—1½d., payable Apr. 2.
***British Tin Investment Corporation.**—18¾%, payable Mar. 27.
†**Broken Hill Proprietary.**—10d. Aust., payable Mar. 28.
***Camp Bird.**—3½%, payable Mar. 25.
***Capper Pass and Son.**—3%, payable Mar. 5.
***Central Mining and Investment Corporation.**—1s. 6d., payable Mar. 28.
†**Consolidated Mines Selection Co.**—1s. 6d., payable Mar. 25.
***Falcon Mines.**—4½d., payable May 9.
†**Fanti Consolidated Investment Co.**—9% and 5% bonus.
Fresnillo Co.—Quarterly 20 cents, payable Mar. 27.
***Ghana Main Reef.**—5%, payable Apr. 1.
†**Jelapang Tin Dredging.**—125%.
***Kaduna Prospectors.**—2d., payable Mar. 21.
***Kaduna Syndicate.**—2d., payable Mar. 21.
†**Kononga Gold Mines.**—6d., payable Mar. 29.
†**Kundang Tin Dredging.**—5s., payable Apr. 2.
†**Larut Tin Fields.**—25%.
***London Tin Corporation.**—20%, payable Mar. 28.
†**McIntyre Porcupine Mines.**—50 cents, payable June 2.
†**Maroc.**—6%.
***Montrose Exploration.**—8¼%, payable Apr. 7.
***Mount Lyell Mining and Railway Co.**—6d. Aust., payable Apr. 26.
†**Nigel Van Ryn Reefs.**—4½d.
***North Kalgurli (1912).**—18¾%, payable Mar. 31.
***Rhodesian Anglo American.**—1s. 7·2d., payable Apr. 23.
***Rhodesian Corporation.**—4d., payable Apr. 9.
***Rhokana Corporation.**—8s., payable Apr. 23.
***Sungei Kinta Tin Dredging.**—1s., payable Mar. 12.
***Transvaal and Delagoa Bay Investment.**—25%, payable Mar. 22.
***Witbank Colliery.**—4s., payable Mar. 20.
***Yarra Falls.**—4%, payable Apr. 23.

METAL PRICES

Mar. 10.

Aluminium, Antimony, and Nickel per long ton; Chromium per lb.; Platinum per standard oz.; Gold and Silver per fine oz.; Wolfram per unit.

	£	s.	d.
Aluminium (Home	197	0	0
Antimony (Eng. 99%)	190	0	0
Chromium (98%–99%)		7	2
Nickel (Home)	600	0	0
Platinum (Refined)	26	15	0
Silver		6	4¼
Gold	12	9	3½
Wolfram (U.K.)			
(World)	4	17	6

Tin, Copper, Lead, Zinc } See Table, p. 176.

The Important Graphite Deposits of the World

Gustav Klar [1]

Published data on mining and beneficiation are summarized

Introduction

In the present paper an attempt is made to present a summary of published and available data regarding the mining and beneficiation of graphite. Based on the principal uses of graphite the list of known deposits has been split into two groups representing microcrystalline and macrocrystalline availabilities respectively.

Graphite deposits in the earth's crust are not connected with particular or even similar geological conditions. They may occur in sedimentary rocks or in crystalline schists, as well as in igneous rocks. Thus, gangue and accompanying rocks may vary widely from deposit to deposit. The same holds good for the crystal system of graphite which could not be defined accurately until very recently, when radiography and the electron microscope enabled mineralogists to ascertain the microstructure of different graphites.

(*a*) *Microcrystalline dense graphites* are inherently distinguished by their high carbon content. Graphites of this kind are usually mined, classified according to their C content, cured, ground to various degrees of fineness, and blast-air inspected. Their uses are chiefly confined to the foundry industry and to the blast-furnace divisions of steelworks. Owing to the intense intergrowth with gangue the separation of this type of graphite (1) [2] by flotation or chemical processes could not be achieved for a long time. The first process of this type was developed and adopted on a commercial scale at Kaisersberg near Leoben-Styria, Austria.

Low-carbon microcrystalline graphites, further vitiated by interspersed limestone and pyrite (S content), are cleaned by wet processing and subsequently briquetted or ground to powder form in suitable mills.

(*b*) *Macrocrystalline silvery-bright graphites*, generally with a lower content of carbon, are made up of larger crystals that will easily separate from the gangue in a flotation process. Chemically this type of graphite can be concentrated to contain up to 99% C. (1). This mode of beneficiation has been standard practice for several decades. In the form of flakes, compounds, and powders the so-called silver graphites find their main applications in the manufacture of crucibles, in the dry accumulator industry, in lubrication engineering, in the production of gunpowder and other explosives, of colloidal graphite, and of steel recarburizers, etc.

Table 1

World Production of Microcrystalline Graphites

	1955
	metric tons.
(1) Mexico	32,300
(2) Austria	17,800
(3) Italy	3,000
(4) Spain	1,200
(5) Yugoslavia	1,000
(6) Hong Kong	1,700
(7) South Korea	99,200
(8) Japan	900
(9) Not nominated, estimate	78,000
Total	235,100

Production of Microcrystalline Graphites

By and large the figures (2) given in Table 1 present tonnages which are exactly the same for production and shipments. No. 9 of the table includes the production of the following countries: U.S.S.R., North Korea, China, Czechoslovakia, India, and the Argentine.

Individual mining activities may be described as follows:—

(1) *Mexico*

Situated about 20 miles south of La Colorado, Sonora, graphite (3) (4) was found in 1867, but the exploitation of the deposit

[1] Vienna: A translation by Dr. Klar of a paper in *Zeit. Erz. Metall.*, Vol. X, Part 6, 1957.

[2] Figures in parentheses relate to the references given at the end of the article.

did not commence until 1895. Mexican graphites contain from 83% to 86% carbon; considerable quantities of ore of which the carbon ranges from 70% to 80% are still being dumped. There are six known deposits, the thickness of individual beds averaging about 10 ft. and reaching a maximum of about 24 ft.

(2) *Austria*

Table 2

Austrian Graphite Mines

Name of Mine.	*Allocated Mining Area (Hect.)*	*Shipments, 1955.* (metric tons)
Kaisersberg	1861·3	11,903
Hohentauern	182·4	4,204
Mühldorf	68·2	1,127
	Total	16,424
	of which : Home Markets	4,034
	Foreign Markets	12,390

The Styrian graphites of Kaisersberg and Hohentauern (5) are bedded in a zone of graphitic shale and phyllite which runs generally along the following line: Semmering Pass—Kapellen–Mürz—Thörl–Aflenz—Bruck—Leoben—Liesing—Palten valley. All the occurrences occur in the zone of greywacke (6).

(*a*) *Kaisersberg.*—Well known for many centuries this deposit was acquired by Mayr-Melnhof in 1840. With several million tons of graphite-bearing rock the occurrence represents the largest interconnected series of deposits in Europe. At least five beds of up to 39·5 ft. in thickness show the vastness of these mineral reserves; the dip of the beds varies from 60° to 85°.

Development and extraction of these graphite beds follows the most convenient method. After cross-cutting a bed rises are put up on the dip, followed by horizontal working along the strike of the bed under its "dome". Once the boundaries of the deposit are reached the remaining graphite is extracted on the retreat.

As mentioned already microcrystalline graphites at Kaisersberg are flotated to give concentrates of from 88% to 92% carbon which are fine-ground to average particle sizes of from 3 to 4 microns.

(*b*) *Hohentauern.*—At Hohentauern (Sunk, near Trieben) a graphite mine was opened up in 1869 by Albert Ritter von Miller. The geological conditions are very similar to those prevailing at Kaisersberg (5) (6) (7). The deposit is worked by exploiting two seams of 10-ft. thickness and more which run parallel to each other with cross-cut distances varying from 66 ft. to 1,000 ft. The topmost underground gallery is 3,820 ft. above sea-level and 478 ft. above haulage level. The material extracted from this mine is of an anthracite-like appearance and is chiefly used as electrode graphite, containing from 85% to 88% carbon.

(*c*) *Mühldorf* (5) (8).—Starting at Marbach and Klein-Pöllarn the graphite-bearing strata of the "Waldviertel" run in 6 to 9 miles width along the line Artstetten—Heiligenblut — Mühldorf — Röhrenbach — Wollmersdorf—Drosendorf. The graphite is embedded in gneissic schists banded in almost parallel lines by quartzites, crystalline limestone, and amphibolites. A deep fold near Mühldorf has been found exceptionally rich in graphite.

In 1813 Thym of Unterranna started the manufacture of black-leaded cooking pots, while in 1832 Weidmann had 30 men on his payroll and manufactured cooking utensils, refractory brick, and crucibles. The washing of graphite commenced in 1837.

Extraction to-day is by underground methods. At right angles to the main haulage road horizontal levels are put out at 33-ft. spacing, with upcasts spaced 160 ft.

(3) *Italy* (9) (10)

In the area of Pinerolo the French-Italian Alps are composed of crystalline schists and limestones, interrupted in places by granitic, porphyric, and other rocks. Lens-shaped beds of graphite occur embedded in the gneiss. In the valleys of Germanasca and Chisone seven graphite mines are being worked, the biggest of them in a location south-west of San Germano. From heights of over 6,600 ft. the graphite is transported down the valley, where it is ground in Melamaggio. A small graphite works is in operation at Bormida, near Genoa.

(4) *Spain* (11)

In the province of Jaèn and near Toledo Spain possesses extensive graphite deposits. They contain up to 65% carbon. However, the major portion of the present production consists of material containing from 7% to 11% carbon only. A graphite works is in operation at Cotos de Guadamur.

(5) *Yugoslavia* (12)

For several years graphite has been mined at Pakrac, but the problem of beneficiation has not yet been solved satisfactorily. The

adoption of a mobile dressing plant has been projected.

(6) *Hong Kong* (13)

The graphite produced by one mining enterprise in Hong Kong is similar to that of Korean origin. The location of the mine is on the " West Brother Island."

(7) *South Korea* (14)

In both South and North Korea there exist vast deposits of graphite. The two Koreas are the largest graphite producers of the world, the production in 1944 being 103,000 tons.

The graphite industry of Chosen (Korea) goes back to 1903, in which year the first exports were made. The deposits mostly occur in seams and irregular lens-shaped beds of dense graphite embedded in schists and sandstone. In Kyeing Sang there are three seams with thicknesses of 50 ft. and 80 ft.

Table 3

Korean Graphite Deposits

Name of Mine.	*Nearest Town.*	*Province.*
Yongdu	Danyang	North Chungchong
Munhwa	Che'chon	North Chungchong
Bongmyong	Munkgong	North Kyongsang
Daechon	Sangju	North Kyongsang
Daechan	Kangnung	Kangwon
Yongdong	Myongju	Kangwon

(8) *Japan* (15)

Japan produced 900 tons of microcrystalline graphite in 1955. The probable reserves are estimated at 1,300,000 tons with an average carbon content of 33%.

World Production of Macrocrystalline Graphites

Statistical data (2) almost invariably show tonnages of concentrates, whereas figures for run-of-mine do not appear and had, for that reason, to be estimated in Table 4. In the following notes a brief account of the macrocrystalline deposits is given :—

(1) *Brazil*

In the area of Itapecerica, Minas Gerais (16), graphites with 20% to 25% carbon are mined opencast. Beneficiation is by flotation and final cleaning. In the form of large flakes or of powder the beneficiated product shows carbon contents of up to 99%.

(2) *Western Germany* (17 to 20)

The Passau graphite mining area, in the southern tracts of the Bavarian Forest, is defined by a line connecting the following towns : Löwmühle — Hauzenberg — Messmerschlag — Wegscheidt — Jochenstein — and from there to the frontier. The extensive Pfaffenreuth and Haar deposits are located inside this area ; at Schaibing, Rackling, and Griesbach isolated pockets have been found.

Table 4

World Production of Macrocrystalline Graphites

Yield of Concentrates in 1955
(in metric tons)

	Concentrate.	*Run-of mine.*
(1) Brazil	1,000	4,000
(2) Western Germany	11,600	55,000
(3) Norway	6,000	17,000
(4) Ceylon	11,100	15,000
(5) Madagascar	16,200	50,000
(6) South-West Africa	1,000	2,000
(7) Kenya	200	2,000
(8) Union of South Africa	1,800	8,000
(9) Japan	2,200	12,000
(10) Not nominated, estimate	13,800	40,000
Total	64,900	204,000

Under the head " not nominated " fall : U.S.S.R., North Korea, Czechoslovakia, *et al.*

The oldest documents in which graphite is mentioned say that the mines of Grubhölzl, near Leizesberg, on the Taxberg near Niederbrünst, and at Hardorf " have existed since time immemorial." In 1250 the inhabitants of Pfaffenreuth had to pay their tithe in form of graphite. A document of 1432 mentions for the first time " pottery made of black-lead material." In 1496 the magistrate of Deggendorf demanded a toll of four Regensburg pennies for each hundred crucibles carted through from the Passau area. Agricola (1494–1555) wondered at the refractoriness of the Passau crucibles. Over and over again in the following centuries evidence is given by documents of graphite mining being carried on in the Bavarian forest. There had been many small mines held by farmers and co-operative societies, but about 30 years ago all of them were amalgamated in the Graphitwerk Kropfmühl A.G.

All the seams in the area are heavily folded, the graphite-bearing strata being composed of four or five groups of seams. The maximum thickness is about 5 ft. ; the limit of workability is at about 1 ft. Thicknesses exceeding 5 ft. are found occasionally in troughs and on crests of folds.

An extensive underground mining system has been laid down for the extraction of the mineral from depths of about 400 ft. The

principal mine is worked from eight levels with a total road length of about 25 miles. The run-of-mine graphites vary in carbon content, being between 15% and 30% generally, but they may be even higher occasionally.

The floated product mining 80% to 95% carbon is classified according to C content, sorted as to particle shape, partly fine-ground, or else chemically concentrated to give a final product of 99% carbon.

(3) *Norway* (21)

Located at the Berg-Fjord, on Senja Island in the Tromsö district, about 75 miles north of Narvik, graphite deposits are embedded in contact-metamorphosed schists. They occur in running lengths of up to 660 ft. and in thicknesses of from 6·6 ft. to 33 ft. Visible reserves have been estimated at 340,000 metric tons, while probable reserves are said to amount to 220,000 metric tons. The average carbon content is about 25%, lower and upper limits for run-of-mine being 16% and 30% C, respectively. The run-of-mine is floated and the flaky product of 80% to 90% C sold to the dry accumulator industry. By the adoption of electro-thermal processes in laboratory testing a product of 99% carbon could be made.

(4) *Ceylon* (22) (23)

Ceylon graphites are mentioned in Singhalese documents from the 14th Century and later in reports of the Dutch Governor (1675). Graphite has been mined on Ceylon since about 1827, the major percentage of the material being for export.

Graphite is found in large tracts of the west and south-west of the island, veins and lodes running through granulite and gneiss. The graphites are generally contaminated with other minerals—such as, pyrite, apatite, quartz, feldspar, mica, topaz, tourmaline, and, in few cases, molybdenite. Graphite mines are located in the area of Ragedera–Maduragoda–Ruwanwella in the north and in the area of Kalutara–Galle in the south-west as well as at Hambantota–Matara in the south. Flaky graphites are produced by the mines of Walakatahena and Kahatagaha, while silver graphites are drawn from Bogola and Karandawatta. Numerous sometimes even hundreds of mines of up to 1,650 ft. in depth produce graphites whose carbon contents vary between 60% and 99%.

To the close of the 19th Century Ceylon led the world in graphite exports and even in 1906 the exported tonnage was as high as 36,578 tons. Ceylon graphite is exported crude and beneficiation left to the importing countries. At present, however, beneficiation plants under construction are expected to push up the sales figure of Ceylon graphites again.

(5) *Madagascar* (24)

Although they had been known long ago these deposits were not exploited until 1908 and then by the Germans L'Allemand and Anton. From huge deposits, that extend almost from end to end of the island, the graphite is mined by open-cast methods. The most important localities are to the south of Tamatave, quite near the sea; in the area of Périnet–Moramanga; in the region of the table-land south of Tananarive, and to the east of Ambositra.

Occurring in a gneissic rock the graphite flakes are almost invariably intergrown with high-potassium mica. Particularly sought after by the graphite-crucible industry are well-formed flakes of up to ¼ in. diameter. The carbon contents of the run-of-mine graphites vary from 8% to 30%, but flotation facilities exist on the island proper. Any processing of the raw graphite is controlled by the State as well as the level of prices.

(6) *South-West Africa* (25) (26)

South-West African graphites of about 50% C originate from Aukam in the Bethania district, from where they are shipped to Johannesburg for beneficiation.

(7) *Kenya* (27)

Kenya graphites originate from Kanziku, near Kitui. The open-cast mined material contains about 10% C and is floated.

(8) *Union of South Africa* (28)

The carbon content of the raw mineral extracted from the Gumbu mines (Sibasa) and from the Mutali mine (Mopani) is about 22%. After beneficiation the final product has a carbon content of well over 80% and is sold in the form of powder or flakes.

(9) *Japan* (15)

The deposits mined in Japan at present are located in the Yamanashiken and the Toyama-ken. The flaky graphites are partly processed and partly utilized in the as-mined state. With an average carbon content of about 13% C the total reserves are estimated at 400,000 tons.

Other Deposits

While more than 100 deposits in the European and the Asian tracts of Russia

have been described (29) from which considerable tonnages of graphite are mined it has not been reported where graphite is mined at present.

The most important Siberian deposit was found on Mount Batugol, in the Tunkinska Range, which is a branch of the Sajan Chain and situated about 270 miles from Irkutsk, near the Chinese frontier. The deposit was discovered in 1840. Beautiful carvings in Batugol graphite hold places of honour in various museums. Round about the year 1860 the deposit of Kureika was found in the area where the Jenissei River flows into the Arctic Sea. High-carbon microcrystalline graphites of Russian origin were exhibited at several industrial shows, but their place of extraction could not be ascertained.

Indian deposits are also quite numerous (30 to 33). In certain parts of India from 1,000 tons to 2,000 tons of graphite are produced per year. The best quality originates from Begumpet, Province of Hyderabad, and good qualities are provided by the Bihar and Orissa mines. The possibilities of profitable beneficiation appear rather under-developed.

Crystalline graphites are drawn from the Sihung mine of the Kyonggi Do Province, of the South Korean Republic (34). Fairly sizeable beneficiation plants are under construction.

In the mountain range of Piė de Palo, Departamento Caucete, Provincia San Juan, Argentine, graphite has been found in several locations. Graphite extracted at Desamparados is shipped to Rosario, Santa Fė Province, for beneficiation. Top-grade concentrates show carbon contents of over 65% C.

At Netolice, Czechoslovakia, graphites are wet processed that originate from the area of Kleinwürben, Goldenstein, and Mährisch Altstadt. Located between Prahatice and Wodnani the Kollowitz Mine produces since 1942 a flinty-type graphite of about 10% C, which is processed by flotation (35). Concentrates are classified into powder grades of about 90% C, flakes of from 93% to 95% C, and some medium flints of from 81% to 82% C.

There are numerous deposits in the U.S.A. (1) (14) (36) (37) which, although the best of modern processing plants were installed, could not be worked on a profitable basis throughout. Known to operate at present is one installation near Auburn Station, Cranston, Rhode Island and one near Burnet, Texas.

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Recent African Experience with the Aerofall Mill

L. A. Waspe

Additional results of tests and operations in Southern Africa are summarized

Gold and Uranium Ores

In a previous article [1] the author outlined the results obtained in "Tests with the Aerofall Mill on a Rand Mine." It has now been shown by further tests on the application of this mill to the reduction of Transvaal and Orange Free State gold and gold-uranium ores, together with the correlation of results obtained from the 22-ft. mill in the Mangula plant (Southern Rhodesia) and from the 17-ft. unit operated on a test basis in the East Daggafontein plant, have indicated that a 26-ft. mill of this type is the optimum unit in respect of capital and operating costs.

The conclusions drawn from the tests outlined and the correlation of results show that the most modern plan incorporating standard or conventional equipment (other than Aerofall) would have operating or working costs of about 3s. a ton at a grind of 80% *minus* 200 mesh, against 1·1s. to 1·45s. a ton in a corresponding plant incorporating Aerofall equipment. Details are presented later in the present review. Other apparent benefits are claimed, such as:—

(1) Filtering rates are increased by about 25%.
(2) Cyanide consumption is reduced by about 35%.
(3) The gold yield or recovery, at the same grind, is raised by 1·5% to 3%.
(4) Acid consumption in the recovery of uranium oxide (U_3O_8) is reduced by about 33%.
(5) The increase in the value of the uranium oxide yield or recovery is about 1·5s. a ton.
(6) The efficiency of the Aerofall mill is raised proportionately according to the coarseness of the feed. This indicates that mining operations could be conducted on the basis of drilling fewer blasting holes and the consumption of less "powder" or gelignite and therefore at reduced costs. No tests have yet been conducted permitting the evaluation of this benefit, or the determination of the optimum degree of fragmentation.
(7) On the whole, it is claimed, results from the mill have exceeded expectations. The Mangula mine is installing a second 22-ft. Aerofall mill, which, with a number of modifications, will probably increase efficiency appreciably and approach near-perfection in operating economies, mechanics, and metallurgy.

[1] THE MINING MAGAZINE, June, 1956.

The 26-ft. Aerofall Mill

On the average grindability of Transvaal and Free State ores the following results should be obtained from a 26-ft. unit:—

Feed—run-of-mine ore, *minus* 36 in.
Operating month—26 days.
Percentage of operating time—95%.
Grind and monthly tonnage:
30% *minus* 200 mesh —130,000 tons
50% " " — 75,000 "
70% " " — 50,000 "

Capital cost of complete installation—inclusive of all liners, motors, switchgear, automatic electronic feed control, automatic electronic air-system controls, all instrumentation (including panel): £271,000.

(*a*) 30% *Minus* 200-*Mesh Grind.*

At this grind of product the 26-ft. mill unit could economically replace all crushing and primary milling units in an existing standard or conventional plant. At least some secondary standard milling units and thickeners would be retained, with the power required for the secondary milling to a grind of 80% *minus* 200 mesh determined at 2,050 h.p. and the total throughput 120,000–130,000 tons per 26-day month on a 95% operating time. Such a modified plant would represent the lowest capital outlay. Total operating or working costs are calculated as 1·45s. a ton (excluding costs of extraction).

(*b*) 50% *Minus* 200-*Mesh Grind.*

On the basis of this grind from the Aerofall section the 26-ft. unit represents the lowest capital cost for a new plant, incorporating no thickeners and only a relatively, or comparatively small, regrind section to give a final product of 80% *minus* 200 mesh. However, test results indicate optimum uranium metallurgy at the 50% grind. In this case the uranium oxide could be extracted from the product of the primary Aerofall section and the regrind effected on the residue from the uranium section. The regrind product would then be treated in the gold recovery (cyanide) section. The rated capacity of the plant would be 75,000 tons a month, with the power required for the regrind section determined at 550 h.p. Total operating or working costs are calculated as 1·25s. a ton (excluding costs of extraction).

(*c*) 70% *Minus* 200-*Mesh Grind.*

At this grind in the 26-ft. unit neither a regrind section nor thickening equipment is required. The indicated metallurgical results range from the equivalent of to better than the returns from a grind of 80% *minus* 200 mesh in a standard plant. The rated capacity of a 26-ft. Aerofall mill installation at the 70% grind is 50,000 tons a month. Total operating or working costs are calculated as 1·1s. a ton (excluding costs of extraction).

All the foregoing results show that even the most modern plants could be economically replaced by equivalent Aerofall equipment.

The Mangula Installation

M. T. D. (Mangula), Ltd.—the associate of Messina (Transvaal) Development Co., Ltd.—has for some months been operating a milling unit comprising a 22-ft. Aerofall primary mill (handling run-of-mine ore without preliminary crushing) and an 8-ft. by 15-ft. secondary or regrind ball-mill. Pilot-plant test runs indicated that such a milling unit would have an estimated capacity of 1,350 tons a day, the final product being 85% *minus* 200 mesh. This tonnage rate was attained not long after the plant was commissioned. At the final grind of 80% to 85% *minus* 200 mesh the metallurgical results appreciably exceeded expectations to an extent inducing the decision to operate at a coarser grind and a higher tonnage rate. At 70% *minus* 200 mesh the metallurgical results remained excellent.

The first full month's operations are tabulated as follows :—

Average daily tonnage—1,432 tons.
Grind—70-72% *minus* 200 mesh.
Power consumption (Aerofall circuit only)—12 kWh./ton.
Power consumption (from headframe to but excluding flotation and including conveying air, handling, and pumping)—14·9 kWh./ton.
Percentage of operating time (with 90% of lost time due to modifications to the air system)—86%.
Labour (headframe to but excluding flotation)—one per shift.
Mechanical difficulties—nil.

The most recent information is that the treatment rate has reached 1,500 tons a day. Modifications being introduced, combined with progressively coarser feed as stoped ore progressively replaces development ore, are expected to give an eventual mill product of 1,700-1,750 tons a day, 70% *minus* 200 mesh. Even with the second milling unit in commission and an eventual total milling rate of 3,200–3,500 tons a day the operating labour will remain at one per shift from headframe to flotation. This is rendered possible by the completely electronic control of operations.

The milling rate of 1,700 tons a day through the first unit at Mangula is expected to be attained in the current quarter, giving an equivalent annual output of 14,400 short tons of concentrates (with an anticipated copper content of about 50%). A milling rate of 3,000 short tons of ore a day through the two milling units is scheduled for attainment in the first half of 1959, with an annual concentrate output of about 25,920 short tons at an overall cost of £44·2 per ton of

concentrate. In due course the company may erect a smelter on rail in the vicinity. Meanwhile the concentrates are being shipped overseas for refining, the cost of which at capacity output is estimated at about £18·75 per ton of concentrate (50%). Capital expenditure at the higher milling rate has been estimated at about £5,200,000. After allowing for royalties the estimated annual profit from the higher milling rate will be £387,000 at a copper price of £180 a ton before providing for taxation, which, however, will be covered by amortization allowances until the capital expenditure has been redeemed.

The Mangula company (which has an issued capital of £4,500,000 in stock units of 5s. each) has exclusive prospecting areas extending over 99 sq. miles, including 103 base-metal claims and freehold of 3,850 acres —in the Lomagundi district of Southern Rhodesia—all about 40 miles from Sinoia. Sulphide ore reserves indicated to-date have been estimated at about 25,700,000 tons, adequate for a minimum life of 24 years at a treatment rate of 1,080,000 tons a year. In the same section of the mine oxidized ore reserves have been estimated at 2,000,000 tons averaging 1·26% copper. In another section the oxidized ore reserves so far have been estimated at about 410,000 tons averaging 3·3% copper. Initial production was achieved about 18 months before the originally scheduled date.

Congress in Canada

John A'C. Bergne, A.R.S.M., M.I.M.M.

A note on the author's visit to Fort Saskatchewan

The Nickel-Copper Plant at Fort Saskatchewan

At first sight it might seem odd to operate a nickel refinery some 750 miles from the mine and mill and nearly as far from tide water. Some compensations, however, include :

(1) Special return freight concessions by the Government-owned Canadian National Railways, as the west-bound concentrates are complementary in part to the east-bound grain to Fort Churchill. There is, in addition, a considerable movement westwards of sulphate of ammonia.

(2) Cheap power from local supplies of surplus natural gas, which also provides the ideal raw material for the production of ammonia.

(3) A suitable site by the North Saskatchewan River for water.

(4) A suitable small satellite township with room for expansion to house labour close to the plant.

(5) Proximity to Edmonton, a large centre of resources for skilled manpower, construction and maintenance firms, cement, and other supplies including power.

The total cost of the plant to date, including a recent $6,000,000 improvement, is a little over $30,000,000. The following account of this intricately balanced process is culled largely from the bibliography set out at the end.

Raw Materials

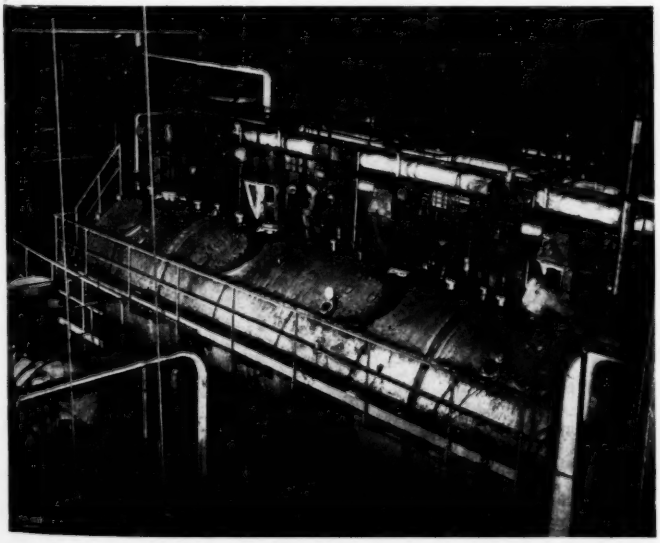
In any description of the Fort Saskatchewan plant a preliminary review is necessary of the raw materials used in it and the sources or methods of production of these reagents. The ammonia leaching process requires the following raw materials and their products :— *Raw Materials* :—Clean hydrocarbon gas, steam, air, and treated water : *Products* :— Ammonia, hydrogen, and hydrogen sulphide.

Gas.—One of the attractions of this site is the proximity of the Red Water oilfield, a few miles to the north of Edmonton, which produces in addition to the oil a considerable amount of dirty gas in solution. As pressure is released this gas is set free and until recently was burnt off by Imperial Oil, Ltd., the operating subsidiary of Standard Oil of New Jersey. The Provincial administration,

General View of Fort Saskatchewan.

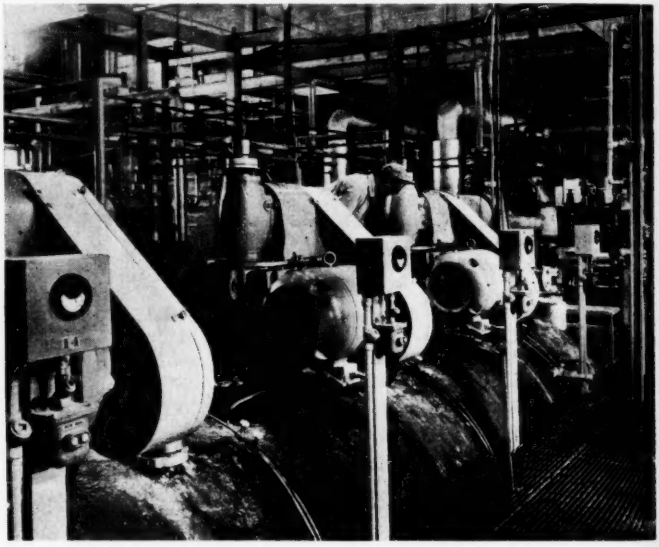
however, have insisted on use being made of this hitherto waste product and accordingly a plant has been constructed, at a cost of $3,750,000 to clean it. At the moment the installation treats 7,500,000 cu. ft. of crude gas per day which is collected by a network of pipe lines from the various wells. The daily products are approximately as follows : 5,000,000 cu. ft. of purified gas, of which 450,000 cu. ft. are used in the plant ; 15,000 Imp. gallons of propane ; 15,000 Imp. gallons of butane ; 5,000 Imp. gallons of pentane, and approximately 9 tons of sulphur. One of the features of the gas stripping plant is that there are only 18 men employed, of whom 12 work a 3-shift system.

However, although residue gas from the Redwater oilfield is used extensively for fuel



Primary Autoclave.

in the refinery, the main supply of natural gas is the surrounding Fort Saskatchewan gas field. For the first eleven months of 1957, the refinery received an average of 5,100,000 cu. ft. of gas daily from the Fort Saskatchewan field and 3,300,000 cu. ft. daily from Redwater. The Fort Saskatchewan gas is purchased for 12 cents/1,000 cu. ft. The residue gas costs 11 cents/1,000,000 B.Th.U. of heat content, which for the first eleven months of 1957 corresponded to a unit price of approximately 14 cents/1,000 cu. ft.



Vertical Stirrers Over Autoclave.

The accompanying flow-sheet, after Nashner, gives an idealized outline of the stripping plant, which is essentially one for fractionating under pressure, using a refrigerated reflux. The purified gas is sold to the Mid-Western Industrial Gas Co. for distribution. The plant of Sherritt Gordon Mines, Ltd., lies about 15 miles away.

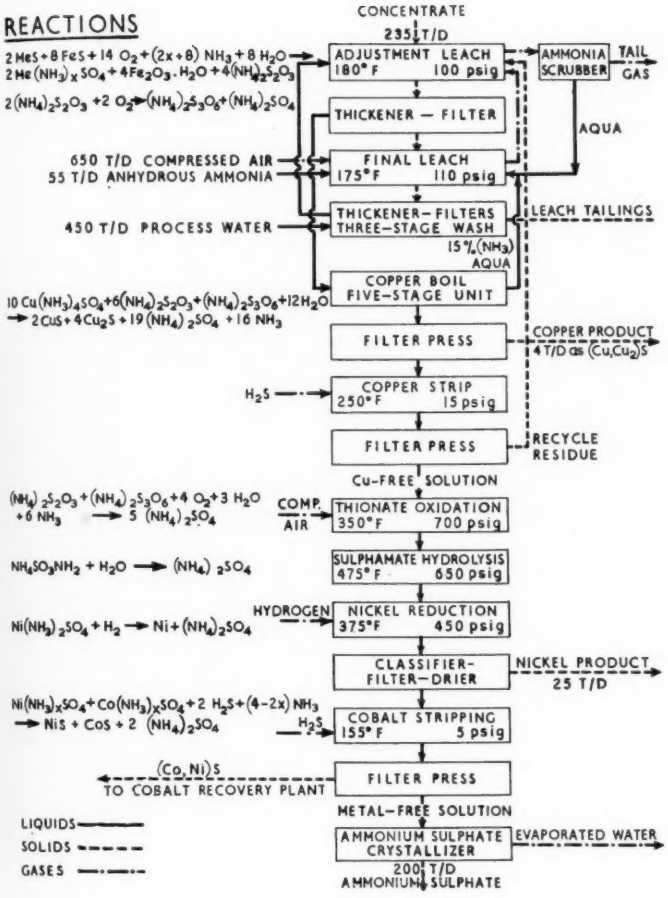
Ammonia and Hydrogen.—These materials are used at a rate of 75 tons per day of high-strength ammonia and two tons per day of hydrogen. They are produced in a plant designed by the Chemical Construction Corporation of New York using clean natural gas, high-pressure steam, and air as raw materials.

Quoting from an article by J. P. Warner, which appeared in the *Industrial Chemist* of September, 1956 :

The production of ammonia involves the primary "reform" of natural gas with steam, and the secondary "reform" with air to supply the nitrogen requirements. The mixed gases then pass through the carbon monoxide converter, where, in the presence of a catalyst, carbon monoxide reacts with more steam to produce further quantities of hydrogen and carbon dioxide. Following this, the carbon dioxide content of the gases is removed by absorption in an aqueous monoethanolamine solution and the gases are ready for ammonia synthesis. The aqueous monoethanolamine solution is regenerated and returned to the gas purification tower.

The synthesis gas is compressed in two five-stage gas driven compressors. Between the fourth and fifth stages of compression the residual carbon monoxide and carbon dioxide are removed by passing the gases through purification towers carrying aqueous ammoniacal cuprous formate solution and weak aqueous sodium hydroxide solution respectively. After compression up to 350 atm. the mixed gases are passed through the synthesis catalysis tower, ammonia condensed out, and the uncombined gases recycled.

A supply of fairly pure hydrogen is required by the nickel production facilities. This is manufactured in the ammonia plant in a separate unit where natural gas is first reacted with steam (primary reform). The further reaction between carbon monoxide and steam is obtained in a catalytic converter. After one stage of compression, the gases are passed through a carbon dioxide absorption tower; an aqueous solution of monoethanolamine, regenerated through the ammonia production system, being used to absorb the carbon dioxide. After a further two stages of compression to 750 p.s.i., the impure hydrogen is sent to the ammonia synthesis building where the gas is purified by passage through aqueous caustic soda and ammonial cuprous formate before delivery



Metals Flow-Sheet. (after Nashner.)

to the metals plant. The hydrogen generator has a capacity of two tons of 99 + % purity hydrogen per day.

The ammonia plant generates sufficient steam from waste-heat boilers and heat-exchangers to supply its requirements where steam is used as a chemical reagent. However, considerable quantities of steam and cooling water have to be supplied by the main power-house for the regeneration of the monoethanolamine and of the other reagents.

Hydrogen Sulphide.—Sulphuretted hydrogen production is still the subject of considerable experimentation on the part of Sherritt Gordon Mines, but it is described in some detail in a paper, dated April 27, 1957, presented to the Canadian Institute of Mining and Metallurgy, in which the Girdler Company's gas plant at Fort Saskatchewan figures extensively.

Water.—Some 1,250,000 gallons of water per day are obtained from the North Saskatchewan River, approximately 1 mile away, and passed through a treatment plant to produce: (*a*) Cooling water, (*b*) process water, (*c*) boiler feed, and (*d*) domestic water.

Steam.—Steam is generated in a series of units for various purposes, including evaporating the ammonium sulphate liquor. Some boilers are gas-fired while others utilize waste heat. The average steam production in the first ten months of 1957 was equivalent to 360,000 gallons of water per day.

Sulphuric Acid.—Sulphuric acid is now used at the last stage in the copper leach. This is produced by an associated company in a

plant alongside the Sherritt Gordon works and piped across. The capacity of the acid plant is 100 tons per day, requiring some 30 odd tons of sulphur.

Leach Plant

The nickel concentrate arriving from the mine assays approximately 14% Ni, 3% Cu, 35% Fe, and 28% S. Originally designed for 235 tons per day of concentrates the plant is now achieving a throughput of about 300 tons per day. The additional capacity has been reached without adding to the size or number of the autoclaves, but by increasing the supply of air and allowing for the provision for heat removal from the autoclaves. This was done by fitting cooling coils in the autoclaves to supplement the heat transfer surface provided by the jackets originally installed on the autoclaves. The temperature control at 180° F. under 100 p.s.i.g. and short contact time of the primary reaction is undoubtedly the secret of this successful process, as polythionates, sulphamates, and other unstable sulphurous compounds which are formed quickly under these conditions, and are preferred for copper precipitation after breakdown in subsequent operations to the more stable sulphates, would be oxidized to the latter with a longer contact time and higher temperature.

A notable feature of the autoclave construction is the seals of the impeller shafts. These are both mechanically and hydraulically perfect, enabling maintenance to be carried out without depressurizing the autoclave. Over 60% of the copper and nickel is dissolved in the primary leach.

After thickening in a 105 ft. diam. enclosed dewaterer and filtering in hooded disc-type filters the dried pulp passes to the secondary autoclaves where the remaining one-third of the values is dissolved at 175° F. and 110 p.s.i.g., the liquor from these passing counter-current through the primaries. The spent pulp after thickening in a second enclosed drag thickening unit is filtered in further hooded disc filters and sent to waste. The wash water used to clean the filtrate goes counter-current to the secondary autoclave feed.

The copper is now stripped from the pregnant solution by a 5-stage reboil unit with two hours retention time. The rate of copper precipitation is increased by a reduction in free ammonia concentration which may be affected either by distillation or by neutralization with acid. The main advantage of acid neutralization is probably a reduced heat load on the system.

The final two stages of the reboil are served with stirrers which keep the sulphide material in suspension. These are eventually filtered off in Sweetland pressure leaf-filter presses.

A final scavenge using a small amount of H_2S at 15 p.s.i.g. and 250° F. reduces the copper content to less than 0·05 gr. Cu per litre. After filtering the liquor is ready for the next stage.

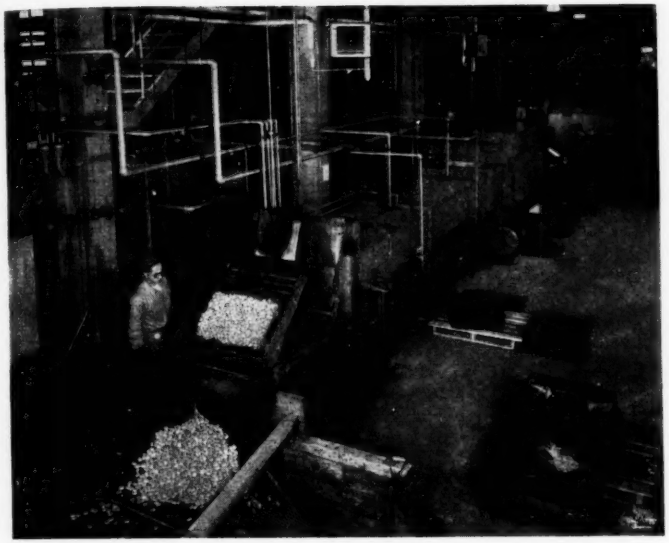
The copper sulphide is shipped to a smelter and reduced to metal in the ordinary way.

Before the nickel reduction can take place the thionates must be oxidized and the sulphamates hydrolysed to sulphates. The solution first passes through a preheater, then through a high-pressure heat exchanger, and then into the autoclaves. Air passes concurrently with the solution through all these units at 700 p.s.i.g., in which the temperature has been raised to 450° F. by steam in a heat exchanger. From the preheater the solution is pumped to two 5½ ft. diameter by 22 ft. partitioned autoclaves fitted with stirrers and raised to 475° F. also by steam coils. The sulphate solution is now transferred to an 8 ft. diameter by 30 ft. holding tank and maintained at 200 p.s.i.g. and 375° F. to 400° F. awaiting the batch nickel reduction.

Nickel Reduction

The nickel reduction is carried out in batches, using four horizontal 6 ft. diameter by 25 ft. autoclaves on a cyclic schedule. These vessels of carbon steel faced with a 10% skin of 316 E.L.C. stainless steel have no partitions but are equipped with four vertical agitators.

Nickel reduction is effected by adding to the solution at 250 p.s.i.g. (oxygen partial pressure of 50 p.s.i.g.) and 200° F., a small quantity of ferrous sulphate as a " catalyst." Agitation then starts, the temperature is raised to 370° F. to 400° F. and hydrogen at 200 p.s.i.g. over pressure. A shower of very fine seed crystals of nickel are precipitated immediately. When the solution has been nearly stripped of nickel the agitators are stopped, the nickel settles, and the spent solution can be blown. A new charge of solution is now introduced, agitation suspends the nickel seed, and on bringing the batch to the correct operating temperature and introducing the hydrogen the nickel seeds grow



Nickel Pelletizing Machine.

and without the catalyst no more seed is formed. This step is called densification.

After 10 to 15 densifications the load on the agitators becomes too great and a partial discharge of nickel is made by keeping the agitators running for a short time at the commencement of the blow. Thereafter partial discharges are made following every few densifications and the end of the cycle is reached after 40 to 50 densifications. This is because the particles of nickel become too large and heavy and the diminution of surface area renders reduction times inordinately long.

The cobalt remains in solution because nickel is reduced preferentially by hydrogen. The cobalt in solution does not react until the nickel reaches a concentration of about 1 g. per litre in the solutions used and the cut off is in about 39 min. of contact time when the nickel has been reduced to about 0·5 g. per litre and some 95% of the cobalt is still held.

The remaining metals are stripped together from the spent solution held at 15 p.s.i.g. and 155° F. by injecting H_2S and filtering out the sulphides. The solution now free of metals goes to the triple-effect evaporator to produce commercial ammonium sulphate, of which some 90,000 tons can be produced in a year. The demand is fluctuating however and storage space has been provided at the works. If stocks are high more attention can be paid to recycling some of the ammonia at various points in the circuits.

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General Comment

The plant at Fort Saskatchewan, with the sole exception of the copper sulphide filtration section, was conspicuously clean even for a modern layout. Small things were noticeable such as no pump gland leaks, nor stains on piping, and this is understandable, for the standard of skill of both plant fitters and operatives have to be of a high order when dealing with explosive, corrosive, and noxious chemicals at elevated temperatures and pressures.

The welding shop was suprisingly small for the size of the undertaking and only one object in it was seen which appeared to have

suffered undue corrosion. This appeared to be a heat exchanger whose clad brass or bronze tubes seemed to have sustained very uneven loss of cladding.

This freedom from corrosion trouble can be traced to the use of extra heavy gauge tubing everywhere. In process vessels a 20% cladding with 316 E.L.C. stainless steel is used, while for corrosive solutions solid stainless-steel pipes are fitted. The cladded alloy seems to be very effective ; no figures were obtained for losses of cladding, if any, but that of the heat-exchanger tubes mentioned seems to have suffered to some extent. On the other hand nickel can deposit from solution under certain conditions and in the precipitation autoclaves the first charge in practice is barren ammonium sulphate solution, which redissolves the layer of nickel plating the inside of the chamber. This charge is then treated as if it were a batch of pregnant solution.

In an operation which was notable for its auto-instrumentation it was curious that the main slurry admission valve to the primary autoclaves was manually operated and apparently used as the means for regulating the admission of pulp. The feed, however, is pumped in after the concentrate has been mixed with the weak solution coming from the lines of secondary autoclaves. To the question whether there was any build-up of ferric hydrate, etc., on the internal surfaces of the autoclaves the answer was that the surfaces were notably clean.

Though this plant is the first of its kind it is in no sense experimental and is now sufficiently familiar to its operators as to encourage them to take in a certain amount of custom ore.

This new departure suggests that there can be considerable latitude in the composition of the material to be treated. It is believed that a number of new plants are being built to make use of the same metallurgical principles so successfully innovated here.

Mining Industry of Tanganyika Territory

A brief survey by the Acting Commissioner for Mines

The following notes are abstracted from the customary "Review of the Mining Industry" put out by the Department of Mines for Tanganyika. Covering 1957 the review concludes with the following paragraph :—

"The decision to sink the third deep test well in the search for oil on the Tanganyika mainland encourages optimism but the existence of oil has yet to be proved. In the face of rising production costs, the fixed price of gold and the depressed price of base metals at the end of the year are matters for concern everywhere, especially to small producers and individual prospectors. The larger companies, however, appear to be taking a long-term view of the situation and are pressing ahead with their prospecting programmes. Progress at the Mbeya pyrochlore deposit, at the Kiabakari gold mine and at the Kyerwa tin mine augur well for the coming year, but diamonds are likely to remain the mainstay of the country's mineral exports for some time yet."

The figures in Table I summarize the mineral output of the Territory for 1957 and 1956.

Prospecting

The extensive aerial prospecting operations which were such an outstanding feature of 1956 gave rise in 1957 to much detailed prospecting on the ground by well-equipped parties using the traditional as well as the most modern scientific methods. The Western Rift Exploration Co., Ltd., with an authorized capital of £1,000,000, took over the special exclusive prospecting licence of 34,000 square miles granted to the Anglo American Prospecting Co. (Africa), Ltd., which remains in charge of the operations. More staff were engaged and their head-

Table I

Minerals.	*1957.* *Quantity.*	*Value £.*	*1956.* *Quantity.*	*Value £.*
Artstone, long tons	1	200	—	—
Copper ore, long tons	—	—	18	362
Diamonds, carats	372,739	3,287,782	357,538	2,855,273
Garnet, long tons	80	2,800	15	525
Gold (refined), oz.	54,088	678,287	59,293	741,582
Graphite (crude), long tons	—	—	23	553
Gypsum (raw), long tons	9,510	17,998	9,450	18,167
Kaolin, metric tons	—	—	10	105
Lead concentrates, metric tons	12,625	882,477	14,251	1,210,332
Lime, long tons	484	2,424	782	3,476
Magnesite, long tons	254	635	243	597
Magnesium bentonite, long tons	50	851	—	—
Meerschaum, long tons	3·51	177	6	290
Mica : Sheet, long tons	67	69,474	57	58,728
Waste, long tons	—	—	125	925
Salt, metric tons	8,572	85,206	9,359	92,613
Silver (refined), oz.	20,520	6,739	35,020	11,504
Tin concentrates, long tons	20·17	10,755	21	11,741
Tungsten concentrates, long tons	—	—	15	10,929
Total	—	£5,045,805	—	£5,017,702

quarters in Chunya was considerably expanded. Communications in the area are assisted by wireless, a Beaver aircraft, a fleet of thirty vehicles and a motor boat on Lake Tanganyika. Field work included examination of the western part of Chunya District, the basic intrusive at Kungwe Bay on the shore of Lake Tanganyika, copper mineralization in the Sango-Karema area, and the Ngualla carbonatite.

New Consolidated Gold Fields, Ltd., which had been granted seven special exclusive prospecting licences aggregating 664 square miles, surrendered that at Luiche in Kigoma District when the source of radioactivity was found to be uneconomic, but interesting mineralization has been found in their Northern Province areas and also at Wigu Hill, in Morogoro District, where the existence of monazite and rare-earth minerals has been confirmed. Copper-gold mineralization near Mara was also examined under a licence covering 42 square miles.

Geological work and drilling undertaken by Williamson Exploration, Ltd., a subsidiary of Williamson Diamonds, Ltd., on three special exclusive prospecting licences totalling 918 square miles, resulted in the surrender of one on which ground work revealed nothing of economic interest ; work on the other two continues. A fourth licence was granted over an area of 185 square miles in Singida District.

The Colonial Development Corporation completed its investigation of the Kivira-Songwe coalfield, near the northern end of Lake Nyasa and a coal-mining lease was applied for.

A well-known mining house applied for a special exclusive prospecting licence in respect of beach sands. Unfortunately the recent severe drop in the price of titanium ores has made the proposition less attractive.

Mineral exploration has by no means been confined to large companies. At Mara two local prospectors discovered scheelite associated with gold in a reef in that area, but the present low price for scheelite may make extraction unprofitable for the moment. Another prospector, with a view to making a product suitable for the East African market, has been experimenting with vermiculite discovered in Morogoro District. Tin miners in the Karagwe tinfield expressed interest in various deposits on the lease surrendered by the Colonial Development Corporation and a number of claims were granted. Five exclusive prospecting licences for radioactive minerals have been pegged by a local prospector in and near the Uluguru Mountains.

The exploration work being undertaken by the BP-Shell Petroleum Development Co. of Tanganyika, Ltd., under exploration licence continued throughout the year. The decision to sink the third deep test well on the Tanganyika mainland was announced and a jetty was constructed at Rushungi on the south side of Kiswere harbour, so that the heavy boring gear could be brought over from Zanzibar where the second deep test well was completed. During 1957 the com-

pany spent over £1,100,000 in prospecting for oil in Tanganyika.

Production

The estimated value of mineral production in 1957 is approximately £5,460,000. An increase in diamond exports offset reduced exports of lead concentrates and gold bullion and the total value of exports is expected to be approximately £5,045,500, about the same as in 1956. A slight fall in the value of minerals consumed within the territory is recorded.

Diamonds.—Production of rough diamonds from both Williamson Diamonds, Ltd., and Alamasi, Ltd., exceeded that for 1956. Exports from the territory showed an increase of approximately 4% by weight and 1½% by value.

At Williamson Diamonds the original pilot extraction plant was converted for use in bulk sampling and the new recovery plant operated with a high degree of efficiency.

At Alamasi the erection of a new bulk sampling plant was begun and improvements were made to the main treatment plant.

Lead.—Production of lead-copper-silver-gold concentrates from the Mpanda Mine of Uruwira Minerals, Ltd., received a serious setback in April when the lower levels of the mine were inundated by river flood water entering the main adit. Fine efforts by the staff succeeded in pumping out the mine and repairing the damaged machinery within a month; nevertheless production suffered and did not reach normal until June.

Gold and Silver.—Territorial exports of gold bullion again declined somewhat. At the Geita mine, where an increased tonnage was milled, further improvements in the mill and powerhouse were made and two new 2,000 cu. ft. per min. compressors were installed. Further development of the mine and increased output is planned.

Output from the Buhemba mine in Musoma District was somewhat reduced, but there was considerable progress at the nearby Kiabakari mine of the Tangold Mining Co., Ltd. Sinking of the main four-compartment vertical shaft continued and had reached a depth of 450 ft. by the end of the year. Much of the new mill to treat between 15,000 and 20,000 tons per month had been completed and an adequate supply of water has been ensured. Preparations are well in hand so that when the mill is completed production can start. This will help to replace the loss in 1956 of Saza Mine as a producer. Elsewhere in the Lake Province activity was confined to a few small workers.

Heavy rainfall on the Chunya goldfield early in the year handicapped the few remaining producers and exports of bullion from this field declined to 4,315 oz. The alluvial output increased somewhat to 923 oz. from 61 diggers.

A little gold was produced at Sekenke and Kirondatal in Singida District. The flats and gravels where the Kironda river enters the plain were drilled in the hopes of finding payable alluvial but the results proved disappointing. Gold and silver obtained from the lead concentrates of the Mpanda mine will also show some reduction this year due to reduced output from that mine.

Mica.—Exports for the year amounted to 67·01 long tons, as compared with 57·22 in 1956. Almost half the mica purchased by local dealers came from the African co-operative societies and most of the remaining exports came from four European concerns.

With the growth of the membership of the Uluguru Mica Mining Co-operative Society, Ltd., to over 1,000 members two separate societies were formed and the lease area was divided between them. Both societies had successful years. Efforts to interest Africans in a neighbouring area to form a co-operative have failed, however, due perhaps to the lack among the population in that area of the tradition of mica mining which exists in the Uluguru Mountains.

Niobium.—At the Mbeya pyrochlore deposits of the Mbeya Exploration Co., Ltd., the 150-ton per day pilot mill came into operation to provide information for the design of a final production mill capable of treating several thousand tons of ore daily. A large stock-pile of ore was accumulated for the new pilot mill. Exploration by means of adits and diamond drilling continued. Possible sources of a power supply, either by a hydro-electric scheme on the Kiwira River or from coal on the Kiwira-Songwe coalfields, were being studied. Metallurgical tests indicate that Mbeya pyrochlore can be treated without undue difficulty to yield high-grade metal.

Salt.—At the Uvinza works of Nyanza Salt Mines (Tanganyika), Ltd., the output increased for the eighth successive year and reached a new record of 16,716 metric tons. Due to loss of favourable weather conditions coastal production was 9,306 tons, a more normal figure than last year's record of 11,495 tons. Exports, chiefly to the Belgian

Congo, amounted to 8,572 metric tons compared with 9,359 metric tons in 1956.

Other Minerals.—The difficulties of the small workers on the Karagwe tinfield caused by the closing of the tin-buying post at Kikagati, were removed when the British Metal Corporation, Ltd., re-opened the post in February. About 20 tons of concentrates were produced. Work on the 1,000-ton per day mill at Kyerwa went on continuously. Erection of the power line from the Murongo hydro-electric power station and the water supply installation were almost completed. Due to the price of tungsten declining still further during the year there was no production of wolfram in this area.

Interest was shown in the small surface copper showings at various places, in the nickel-bearing occurrences at Haneti, north of Dodoma and in that at Kungwe Bay, near Lake Tanganyika. Further drilling was carried out by the Geological Survey Department on the Liganga iron deposits with a view to estimating more closely the tonnage available.

The East African office of the United Kingdom Atomic Energy Authority was opened at Dodoma during the year to encourage the search for radioactive minerals and to assist prospectors and mining companies with technical advice and facilities. Among the various tasks undertaken by this Authority during the year was an examination of certain hot springs for helium, the occurrence of which had already been recorded by the Department of Geological Survey.

The weight of gypsum exported during the year for use in the cement industries in Kenya and Uganda was 9,510 tons. The Ilima mine in Tukuyu District produced 1,331 tons of coal during the year, apparently sufficient to satisfy the present local market. The Tanganyika Meerschaum Corporation continued their active examination of the deposits of that mineral on the Kenya border and mechanized mining with the introduction of pneumatic picks and mechanical loading and transport in the open casts. The production of meerschaum pipes at their Nairobi factory was considerably expanded. There was a small export of magnesite; bentomitic clays associated with the magnesite deposits also received attention. This material, when of sufficiently high quality, is valuable for filtration purposes and for use in deep drilling operations. A company was formed to exploit the garnet deposits at Namaputa in Masasi District and trial shipments of the mineral were made. The quality of the garnet is known to compare well with standard commercial grades of this abrasive material.

Mining Titles

At the end of the year 27 exclusive prospecting licences over area aggregating 36,163 square miles, 2,224 claims and 51 leases covering 331 square miles were current as well as an oil exploration licence covering 25,300 square miles of the coastal area and off-shore islands.

Ore-Dressing Notes

(9) *Production.*

Improvements at Sullivan

The milling section at the Kimberley mine of the Consolidated Mining and Smelting Co. of Canada, Ltd. (Cominco), continues to make progress in the automation of its complex mineral-dressing problems. Among the possibilities which promise to become steady factors in plant operation are the continuous automatic feed of reagents in the flotation circuit and close control of the bath density in the dense-medium separation. A standardized rapid determination of zinc has already been worked out and gives the operators information in less than an hour, sufficient to guide their work in this section, while dezincing of the lead concentrate is also now a standard practice. The mill at Chapman Creek was built in 1923 and has been expanded by steady stages to its present capacity of 11,000 tons per day. It treats an intimate mixture of galena, marmatite, and pyrrhotite. Coarse crushing to 40% *plus* 1 in. feed is done underground and dense-medium separation is practised at the plant. Some 30% to 35% of the entering feed floats and is either rejected or sent back with a pyrrhotite concentrate to act as a bonding cement for use in back-filling the stopes. After rod-milling the sink fraction goes through three stages of grind which includes coarse reduction and a float for lead. This coarse lead concentrate becomes the make-up medium in the sink-and-float plant. After

fine grinding the rest of the lead is taken and this is followed by zinc flotation, followed again by the removal of cassiterite from the tailings which receive a final treatment for iron sulphides before the gravity treatment on Buckman tables is applied.

Results at Sullivan show that pH and residual xanthate concentration tie very closely with metallurgical results.[1] A method for analysing mill pulps for residual xanthate has been worked out and correlated with the effect on the tailings. Attempts are now being made to tie xanthate concentration and pH with recovery automatically in the shape of a recorder *plus* controller that can automatically change the rate of reagent feed to the circuit as the ore characteristics themselves change. A continuous measuring spectrophotometer together with a recording pH meter are the main present instruments of development research. These are to work on the tailings end of the zinc circuit. The spectrophotometer must receive a crystal-clear solution and this requires double filtration of a representative sample, a filter cloth followed by filtering through a ceramic plate being used. Part of the filtrate goes to the pH recording, where some cloudiness can be tolerated, while the gin-clear ceramic filtrate goes to the spectrophotometer which requires 150 c.c. of solution for measurement. The problem of tying the recorded results to change in reagent rate is the next hurdle ahead.

In the dense-medium plant the optimum specific gravity is at present 2·95 and compensation must be made for variation in the water arriving in the separating bath, density being adjusted by means of make-up medium from the coarse lead cells. Originally this was corrected by half-hourly manual checks, but a continuous recorder, based on the bubble-pipe principle, now gives a continuous record. Variation from the standard bubble-pipe technique for two pipes is a purging of the standard tubes by water which eliminates the plugging at the ends of these tubes at first experienced. A controller is being considered to take the actual change in rate of addition of coarse galena out from manual control following readings of the dial showing changes. Already at the time the information on which this note is based was given considerable improvements have been made by use of the information on the continuous recorder.

[1] See *Min. Engg.*, July, 1956.

To make a rapid analysis of the tailings the dithizone method of colorimetric determination is used. A 0·5 g. dry sample is digested with nitric acid and taken to dryness, taken up with hydrochloric acid, and diluted to 500 c.c. with water. One c.c. of the dilute solution is added to 10 c.c. of a buffer solution and 10 c.c. of 0·01% dithizone carbon tetrachloride solution is added and the test tube shaken vigorously. The colour developing in the dithizone carbon tetrachloride layer is compared with standard indicators. The method is very sensitive and care must be taken to avoid contamination. The buffer solution contains sodium acetate and glacial acetic acid. Ammonium citrate is also used to remove discolouration and sodium thiosulphate to eliminate lead interference.

The lead-zinc ratio in the Sullivan ores has changed over the years and dezincing has now become economic. The recleaned lead concentrate is conditioned to depress the lead and much of the zinc contaminating it is floated away. The tailing from this treatment is the final lead concentrate. The low-grade zinc float is blended with clean zinc concentrate from the zinc recleaning operations proper and becomes the final zinc concentrate. This has improved the grade of lead concentrate with corresponding reduction of its zinc content.

(10) *Flotation.*

Radioactive Tracers in a Circuit

The use of radioactive tracers in a flotation circuit to examine the action of reagents and various other effects is reported in a joint paper in the *Canadian Mining and Metallurgical Bulletin* for March, 1957. Among the information which this use of radioactive material may be expected to yield is contact time, grinding efficiency, size distribution, extraction, and circulating load. It is also possible to label and trace specific ore samples through a circuit. The paper, by six authors, describes work done at Quemont, Quebec. Attention was concentrated on the path taken and on the consumption of the copper sulphate used as an activator for the zinc before its flotation and on the distribution of radioactive ore particles added to the normal mill feed ; copper-64 was the isotope used. It has a 12-hr. half life and could easily

be obtained quickly at Quemont, having the advantage that the radiation is sufficiently energetic to be picked up without difficulty (carbon-14 is not of much use for this type of work because of the low energy of its beta radiation). In transport the level of radioactivity must be kept down to below some 200 millicuries in order to avoid radiation hazards. Preliminary tests show that 12 millicuries of copper-64 added to the head of the zinc circuit could be detected in samples of flotation product amounting to some 150 c.c.

The most convenient method of study would be on activated ore samples which were returned to circuit. This would raise difficulties regarding any changes in their physical condition during the process of activation and return. The sample should be made radioactive within the largest practical size range and added in the grinding circuit so as to ensure freshness of surface. Background counts were reduced by the use of a heavy lead " castle " in which the sample could be tested in 400-ml. beakers.

For the copper sulphate experiments metallic copper was irradiated at Chalk River, converted to sulphate, and then flown in a small lead container to the place of use, where it was dissolved in a bucket of water and poured into the aerating tank. No special precautions were needed in handling. Because of the short half-life of copper-64 the activity of the material was only a quarter of that on the previous day. The zinc minerals were far more active and were transported in special packing. For the tests they were introduced to the circuit by hand after mixing with ordinary ore in a bucket. G.M. counters checked that no dangerous spills had occurred. In the first experiment radioactive copper sulphate was added to the normal copper sulphate for activating zinc prior to flotation. The object of the work was to establish detectability of tracer, to measure contact times, and to get some quantitive results on consumption of copper sulphate in flotation. The results of these tests and those made on radioactive zinc ore are presented in the paper quoted in a series of graphs. They do not lend themselves to discussion in an abstract of this type, but the note is made in order to draw the reader's attention to a record of what is perhaps a new type of test work of which no doubt more will be seen as the techniques are perfected.

(11) *Production.*

Cyclones and a Handling Problem

Early in 1955 a cement company in California had the problem of handling larger volumes of finished slurry through its existing pipelines. The question of duplicating the classifiers, pumps, and pipelines was considered and it was decided rather to install liquid cyclones to handle the increased tonnage through the existing network. The mill feed of *minus* 2 in. crushed limestone and shale was given primary and secondary grinding, at that time finishing through bowl classifiers which limited production to 70 tons per hour per unit. New crushing was first provided to bring down the raw feed storage to *minus* 1 in., thus reducing the work on the wet grinding system. Experiments were then made with a proprietary cyclone.

In a descriptive article J. T. Curry [1] gives details of the problems of balancing the circuits and obtaining a consistent *minus* 200 mesh final product. The points noted here are that the apex valves made of moulded rubber last about 100 days and are the only parts of the cyclone to show appreciable wear. Experiments are being made with an apex valve with a ceramic insert which may prove better. Large quantities of water were originally needed with the bowl classifiers to get an 88% *minus* 200 mesh separation. This limited the finished slurry to between 12% and 15% solids, a solid/liquid ratio of about 1/6·5. The transport of this slurry put a heavy load on pumps and pipelines and when production was to be increased 35% the obvious step was to reduce the total volume of water to be pumped. Liquid cyclones have made this possible by bringing the slurry up to a solid/liquid ratio of 1/1·9.

This elimination of over 4½ tons of water for each ton of solid material handled has led to substantial power savings; 43% more material is now being treated and the reduction of the slurry handled saves between 23% and 48% of the original power cost. This item does not normally appear in mill work, but might be taken into consideration when weighing the relative advantages of conventional closure of a circuit by mechanical classifiers and by use of the cyclone.

[1] *Min. Engg.*, Oct., 1957, p. 1109.

Book Review

Metalliferous Mine Surveying. By F. WINIBERG; fourth edition, revised and enlarged by R. C. A. HOOPER. Cloth, octavo, 404 pages, illustrated. Price 50s. London: Mining Publications, Ltd.

The fourth edition of "Metalliferous Mine Surveying" has been revised and enlarged by Mr. R. C. A. Hooper, of the Camborne School of Mines. The book is 404 pages in length in comparison with 336 pages of the previous edition (1950). There is an even greater increase in subject matter than is apparent from these figures, as many of the diagrams have been reduced in size. The general layout and arrangement of chapters is unchanged.

The chapter on theodolites now contains a description of an optical-scale theodolite. It is very probable that instruments of this type will eventually replace all vernier and micrometer theodolites in mining and engineering surveys. Their success depends upon improved techniques for graduating glass circles.

The triangulation chapter has been revised and now describes the adjustment of quadrilaterals and polygons with worked examples.

Chapters IV and V cover field astronomy. This is the least satisfactory part of the book, for many of the methods advocated are of academic interest only. Modern methods of astronomical "fixes," whether for precise geodetic work or for rapid location in sea or air navigation are almost invariably based upon some type of "position line." These methods, which could well be described as "standard," are not mentioned. However, the value of the astronomical examples has been increased since the last edition, as the stars that are used have been chosen with more care. Unfortunately, this improvement is offset by the reviser's frequent references to the "Nautical Almanac." This annual publication was revised in 1951 and in its new form is no longer of use to the surveyor, for much of the information that he requires is now omitted. This data, such as the position of stars, is now published in a new textbook called the "Star Almanac for Land Surveyors" (H.M.S.O. 3s. 6d.).

Chapter VIII, formerly "Tacheometry," is now headed "Tacheometry and Contouring." This change in title is fully justified, for the chapter has been re-written and enlarged. In surface surveying the mining engineer employs tacheometric methods much more frequently than does the land surveyor or the civil engineer and this revised chapter, with several pages devoted to contouring, will be useful to the beginner and expert alike.

There are no major changes in the chapters that describe the orientation of underground workings, but the section describing underground setting-out has been increased from 25 to 42 pages and is now very comprehensive.

The methods of stope surveying described in Chapter XVI are unchanged, as the whole chapter was revised in the third edition. A section has been added on the setting of planimeters and their zero constants.

This publication is easily the best book available on metalliferous mine surveying. Despite its title it is also of more use to the colliery surveyor than many textbooks that cater exclusively for him.

J. S. SHEPPARD.

☛ Copies of the books, etc., mentioned under the heading "Book Reviews" can be obtained through the Technical Bookshop of *The Mining Magazine*, 482, Salisbury House, London, E.C.2.

Malayan Mining

A report on the mining industry in Malaya, covering the years 1950–1955, is the first of a new series planned by t e Department of Mines in the Federation. The Chief Inspector, Mr. Ian L. Patterson, responsible for its preparation, points out, according to our correspondent in Singapore, that this first report actually covers six years, from 1950–1955 and that, indeed, it gives the basic facts on the developments that require to be recorded from 1949 onwards. It is noted that with a view to attracting Malayan youths to the mining profession the department obtained permission in 1952 to award federal scholarships for overseas training. Since then federal scholarships and those offered by the New Zealand Government under the Colombo Plan had been available for award in excess of the numbers of suitable candidates coming forward. A few state scholarships had also been awarded for mining and a small number of private scholars had gone overseas to study mining. By the end of 1955 four federal and Colombo Plan scholarships had been awarded and it was believed that a genuine interest in mining as a career had been aroused. The first

Malayan senior officer to be recruited—Mr. Lim Leong Sing—joined the department in May, 1955, on a temporary basis, in the research division.

In a country which is the world's largest individual tin producer the emphasis remained largely on tin mining, but increasing interest in the production of accessory minerals associated with cassiterite and the mining of iron ore and of bauxite was rapidly extending the department's research division's activities. The earliest task of the research division, created in 1951, were concerned with : (*a*) The development of an efficient method of batch froth flotation for the treatment of tin concentrates associated with sulphides and sulphide-rich dumps (rejected from earlier treatment methods) containing appreciable quantities of cassiterite, and (*b*) the development of a combination of high-tension (electrostatic) and magnetic methods for the separation of cassiterite from zircon and monazite and for the preparation of high-grade monazite concentrates. These two tasks attained historic importance when, says the report, towards the end of 1953, it was possible to advise the then finance committee of the Legislative Council that the infant research division—for which funds were being asked for the construction of a permanent headquarters and laboratories—would have spent a total of less than (Malayan) $400,000 (mainly on capital equipment) in the first three years of its existence and that the result of those two tasks alone had already brought in over $6,000,000 in extra revenue.

Other important schemes undertaken during the period under review included an interesting application of high-tension separation to clean scheelite concentrates containing gold and sulphide impurities and some fruitful work in the field of improving the grade of columbite concentrates, as well as on the use and application of hydrocyclones and spiral concentrators. Several small pilot-plant installations were set up in the field, but staff shortages prevented very much being done in this very important sphere.

Due to conditions peculiar to Malayan tin mining it was decided that the only satisfactory way in which certain problems could be investigated was to operate an experimental alluvial tin mine, which it was proposed to do at a later stage when more staff was available. In addition to serving the purposes of providing experimental and long-run test data the experimental mine would also serve admirably for demonstration and educational purposes.

The value of the new wealth created by the mining industry in developing the mineral resources of the Federation is measured precisely as the gross value of all minerals at the point of export and of those sold for domestic consumption. This value averaged (Malayan) $432,000,000 per annum during the period under review, of which about one-quarter accrued directly to public revenues in the form of export duties, royalties, and income tax, while the bulk of the balance of this new wealth was put into circulation, or used to service the capital employed or to acquire new capital assets in the Federation.

New prospecting continued to be hampered owing to the Emergency conditions, which restricted access to outlying places. Some improvement was noticeable from 1953 onwards, when it was possible for prospecting parties to be allowed to enter certain areas which had been cleared of Communist terrorists. Nearly 500,000 acres of land were held under mining title in the Federation. The grant of a mining title normally follows the selection of payable areas found as a result of prospecting.

During 1951 the post-war peak number of 83 dredges were in operation, a number of which have since been closed down after the reserves of dredgeable ground in the properties on which they were situated had been worked out. It was probable that the total number of dredges in operation would further decrease, since the old, small, shallow-digging dredges were unsuited for removal to the lower-grade deeper ground constituting the bulk of the future reserves of the dredging section of the industry. Steady progress continued to be made by all mining groups in increasing the efficiency of the older medium, and larger, dredges. Some, with a substantial life to run on their original properties, were given major overhauls and/or were converted to electric drive, or were equipped with improved treatment plants. Others were similarly brought up-to-date or otherwise redesigned to suit the new working conditions on their transfer to new properties.

A novel method of moving a dredge from one property to another was employed in Perak during 1953, when a large modern dredge was floated through a canal for a distance of one and a quarter miles. The

passage was made in five hours, partly under the power of the dredge's own winches and partly by being towed by heavy tractors. It was reported that the removal of this dredge in this manner resulted in the saving of some (Malayan) $2,000,000 and more than one year of lost time, as compared with the cost of, and time involved in, dismantling and re-erecting the dredge in the ordinary way.

At the end of 1955 76 dredges were in operation and 17 were idle—seven under active overhaul or removal to new sites and eight idle due to exhaustion of reserves. Of this latter number, it was probable that four or five would be unsuitable for removal and re-erection on any new property and should, therefore, be regarded as obsolete.

In the gravel-pumping section there were a number of significant developments, the most important being the continuance of the trend towards electrification and the wider use of vertical shaft pumps direct-coupled to the motor.

The use of more mechanical digging and earth-moving equipment in the larger mines in the traditionally conservative Chinese gravel-pump section of the industry was symptomatic of the economic pressures imposed by increased labour costs.

There was a noticeable change in the trend of employment of diesel engines—where these were preferred or where electric power was not available—towards the use of the lighter high-speed engines in preference to the heavy low-speed designs which were previously so much in favour. The lighter engines can be moved from site to site without having to be completely dismantled and, not requiring such expensive foundations, they promote the flexibility required by the operators of the medium and smaller mines.

Developments at the large underground tin mine at Sungei Lembing, Pahang, were not without interest. More diamond drills were brought into use for development work and, during 1952, skip winding was installed in place of the former truck-and-cage system in the Nicholson shaft, showing considerable economies in reduced hoisting costs. During 1953 the mill was modernized by the replacement of the old Californian stamp-battery by ball-mills and by the installation of a new flotation circuit and additional tables. The flotation circuit now produced a copper-rich float of mixed sulphides for which a market was found in Japan. During 1954 an air-conditioning unit was installed in the Willinks section, at the No. 44 (internal) shaft, to cool and dry the air at the lowest levels, from 1,100 ft. down to 1,400 ft., where the miners' work was being hampered by exceptional conditions of heat and humidity.

The only other substantial underground workings for tin were those at Kajang Kemaman, Trengganu, where a series of lodes were being developed from adits. These operations were seriously hampered by Communist terrorist activities and were closed down by order in December, 1951. Conditions improved sufficiently in 1955 for permission to be given to resume operations.

The extension of the use of belt-conveyors for the whole of the main trunk haulages in both the big open-cast tin mines near Sungei Besi, in Selangor, and on the quarry faces of the large tin mine at Klian Intan, in Perak, were the most significant developments in these mines.

Engineering Log

The tenth Dalton lecture " Coal and Coal Chemicals in the National Economy " was delivered by Dr. J. Bronowski on October 25 last. As would be expected, the Director of the Coal Research Establishment of the National Coal Board was able to give a lucid and broad survey of the future of British coal and its mining. In our country only two forms of coal consumption still increase rapidly: The generation of electricity has gone up some 80% during the past ten years and that of metallurgical coke by about 60%. Other uses are either stationary or falling. Dr. Bronowski estimates that by 1975 some 50,000,000 tons of coal will be needed for metallurgical coke. While oil has a flying start in chemical use, because of its flexibility and of the research which in the past has been devoted to finding products, coal lends itself more readily to the production of aromatics. Fluid-bed treatment as against that in the fixed bed of a coke oven leads to high yields of liquid products and converts the resultant coal to a powdered char which can be briquetted to make a smokeless fuel for domestic use—a process probably still in its infancy. Smokeless fuels, however, may not be in permanent demand, so that gasification of the char

must be looked into for the purpose of producing rich heating gases or synthesis gas for oil production. With the possibility by the end of the century of a major advance in the generation of electricity by nuclear power, and of the availability from similar sources of cheap electrolytic hydrogen, the possibility of direct hydrogenation of coal, which is at present uneconomic, is not to be overlooked. Perhaps by the end of the century, it is suggested, single-stage steel production will have been further developed and if that should occur coke ovens will then be needed only for foundry coke. It is evident there may be vital change in the prospects for Britain's major basic industry and the production of steel which stems from it.

* * *

Michigan State University reports that a new method of pasteurization, using higher temperatures, may help to keep milk fresh longer. At ordinary refrigerator temperatures of about 40° F. milk pasteurized by the ultra-high temperature method can be expected to keep at least 25 days ; pasteurization by standard methods enables it to be kept only 14 days in such conditions. In the new process the temperature used ranges from about 190° F. to 280° F., for a short period, while in the conventional vat method it is heated to 143° F. and held at that temperature for 30 min. or in standard high-temperature short-time process it is held at 161° F. Milk pasteurized by the new process will spoil eventually, but the research team reports that this process provides milk with 1,000 times less bacteria count than other pasteurized milk of proved safety. The milk is already on sale in test areas, where many consumers find that it has a sweet, nutty flavour and appears to be " richer " than milk produced by the older processes.[1]

* * *

Construction of Hinkley Point, the largest atomic power station in the world, is estimated to be completed in 1962. It will have an electrical output of 500 MW, which is almost seven times that of Calder Hall " A " the world's first full-scale atomic power station. The main civil engineering and building contractors are Taylor Woodrow Construction, Ltd., members of the English Electric–Babcock and Wilcox–Taylor Woodrow group who are responsible for the design and construction of the station to the order of the Central Electricity Authority. To ensure a solid foundation for the cooling water intakes it was necessary to erect an offshore drilling tower so that rock samples could be taken from 50 ft. below the sea bed. The tower used for this work was constructed from 2 in. diameter steel scaffold tubing and spring-steel fittings, the framework being stiffened with cross tubes. It was erected on site, slung between two pontoons, towed to the drilling position 2,000 ft. offshore, and then sunk in a mean depth of 40 ft. of water, the tower at high tide standing 30 ft. above sea-level. The structure was stabilized by attaching it with guy ropes to concrete blocks resting on the sea bed. Proof of the structure's strength can be given by the fact that it withstood frequent gales and heavy seas.

Mills Scaffold Drilling Tower.

* * *

Electronic computors are beginning to find their way into British offices on a larger scale. More than 80 have been ordered for 1958, of which 20 have already been delivered. The first stage of using them is rather slow, as the working out of programmes cannot be done quickly. Such machines are used in two main ways—to aid management by working on the controls of stock, cost, and

[1] *Science Digest.* Feb., 1958.

statistics, or to eliminate a good deal of routine clerical work as in the calculation of pay rolls. To show the slowness with which a computor works up to full activity one installed last July is now working a 5 to 6 hour day on routine. Much of the spare time left is being used in preparing for extension of its work, but it will finally be loaded to its full capacity of at least 20 hours daily. Many clerical and managerial functions are affected and their operation must be re-adapted before the computors fit happily into office routine. The modern machine used in business has a very capacious " memory " together with rapid devices for feeding information and extracting it from the machine. The large magnetic drum is much in use by one company for storing information ; smaller drums are already widespread and magnetic tape is also becoming available.

* * *

A recent report ssued by the United States Bureau of Mines [1] describes the development of a simple and accurate method for using X-ray equipment to analyse rare-earth ores, metals, and compounds which has removed a major barrier to research on a group of little-known metals of growing military and industrial importance. The new technique makes it possible to analyse 40 samples for seven elements each in a single day, a result which promises to speed up research aimed at finding more efficient and economical methods for separating and purifying the individual rare earths and determining their properties. The basis of the new technique—X-ray emission spectroscopy—is that every element has a characteristic simple X-ray line spectrum. High-energy X-rays directed at a finely-ground rare-earth sample cause the atoms of the sample to become excited and re-emit fluorescent X-rays, which are characteristic of the elements in the sample. In the Bureau's method these rays strike a special crystal, which reflects the characteristic line spectra of the various elements at different angles as its face is rotated. Use of instrumentation or automation virtually eliminates the chance of human error, so that within limits the technique provides an accurate method for determining the purity and making quantitative analyses of rare earth preparations.

[1] *Rep. Inv. U.S. Bur. Min.* 5378. " X-Ray Emission Spectrographic Analysis of Bastnaesite Rare Earths."

News Letters

VANCOUVER

February 8.

Legislation.—Severe criticism of restrictive mining legislation enacted in 1957 by the British Columbia Legislature and subsequent Orders-in-Council was voiced at a panel discussion sponsored by the Vancouver Board of Trade on January 7. The Government was represented by the Minister of Mines, the Hon. W. K. Kiernan, who defended the policy of effectively restricting the export of iron ore and of replacing the Crown-grant system of mineral-claim tenure by a system of temporary leases. Despite the unanimous support of the assembly to the speakers, who not only criticized but actually held up the new legislation to scorn, Mr. Kiernan made a courageous effort to justify the policy on socialistic principles and the trust rightly or wrongly imposed upon the Government to protect the rights of the people. He contended that the export of iron ore was delaying if not nullifying the establishment of an iron and steel industry in the Province and therefore the new tax on ore in the ground was fully warranted.

The other panel speakers, Dr. D. F. Kidd, consulting geologist and past president of the Canadian Institute of Mining and Metallurgy ; C. H. Mitchell, editor of the *Western Miner and Oil Review* and executive secretary of the Sixth Commonwealth Mining and Metallurgical Congress ; Lionel P. Kent, chartered accountant and recognized authority on taxation, and Dr. Howard T. James, geological and mining engineer and exploration manager of Pioneer Gold Mines of B.C., Ltd., condemned the policy of the governing Social Credit party in no uncertain terms. They insisted that the effect of this policy was exactly the opposite of that desired and said it was stifling prospecting and exploration of iron deposits. They contended that the arbitrary powers conferred on civil servants could have a corrupting influence and that it was entirely possible the civil " servant " would become the civil " master." They told the meeting that risk capital has turned its back on British Columbia because of what were thought to be ill-conceived, inexpedient, and unnecessary legislative enactments, which included such detrimental detail as punitive and discriminatory taxation, restriction of tenure,

elimination of indefeasible title, substitution of ministerial discretion for statutory rights, and the introduction of the thoroughly discredited concept of taxation of ore in place.

The Board of Trade panel discussion has had the desired effect of bringing the deplorable state of the mining industry before the people of British Columbia and of Canada. The matter indeed has international ramifications for the Japanese obviously resent the action of the B.C. Government in seriously curtailing if not eliminating this source of supply of iron ore, contracts for the purchase of which were negotiated well in advance of passage of the legislation. The *Japan Metal Daily* of January 18, 1958, states :—

> Japanese steel circles are reported to be highly critical about an export duty recently levied on iron ores by the Provincial Govenment of British Columbia on shipments by Quatsino and Texada iron mines. Competent circles in Japan are reported to be of opinion that the step taken by the Provincial Government is a discriminatory measure against Canadian iron ores to be exported to Japan in view of the fact that quantities of iron ores are being shipped from that country (Canada) to European countries as well as the United States free of any export duties. It is believed in informed circles that the Japanese Government is sharing the view taken by these competent circles while a section of trading circles is urging that some proper counter measures should be taken in retaliation. In this connection, informed sources opine that the imposition of special import duties on grains and lumber to be shipped to Japan from or through the various ports in British Columbia may be one of such counter measures.

Various public organizations associated with the development of the mining industry have implored the Provincial Government to rescind the detrimental legislation and to offer in its place some encouragement to the industry through the present unfavourable times of declining metal prices and possible United States tariff impositions. The British Columbia and Yukon Chamber of Mines has demanded the withdrawal of the tax on ore in place and the restoration of clear title to any mineral claim. The retiring president, at the annual meeting of the Vancouver Stock Exchange, stated in part :—

> Obviously the Provincial Government must re-examine its policies to decide whether or not the hope of obtaining a domestic iron and steel industry based on a relatively limited local market and ore reserves, which as yet are not large, is a sound calculated risk to take when weighed against the effect of such action on our entire mining industry and on the standing of this Province in the mining world.

The Mining Association of British Columbia, an organization of operators, on January 31 unanimously approved the following resolution :—

> Resolved that this Association recommend to the Government of British Columbia that they engage some nationally recognized firm of consulting engineers familiar with the Steel Industry to thoroughly investigate all aspects of a basic steel industry in British Columbia and to report on the economic feasibility—either now, or ar a later date—of the establishment of an industry based on the reduction of iron from British Columbia sources in addition to scrap and, if it should be feasible, the extent to which it must be integrated with existing activity in order that its economic success be assured, and further that such a report be made public.

Skeena.—The Bedford American Petroleum Corporation has been incorporated with head office in Tulsa, Oklahoma, as a wholly-owned subsidiary of Premier Border Gold Mining Co., Ltd. The new company will acquire, hold, operate, and manage all oil and gas properties of Premier Border in the United States. The parent company has obtained a 25% interest in association with Canadian Homestead Oils, Ltd., and others in Panny River Reservation No. 3133 of 50,000 acres in Alberta. Premier Border has also obtained a 5% interest in a 2,500-acre block adjacent to the Leduc reef in the North Glen Park area of Alberta. Partners in this venture are Imperial Oil, Ltd., Texaco Exploration Co., Ltd., Triad Oil Co., Ltd., McColl-Frontenac Oil Co., Ltd., and Canadian Homestead Oils, Ltd. The last-named company, as operator, commenced on January 21, 1958, the drilling of a test well to a projected depth of 7,700 ft. Premier Border is maintaining its Northern Lights base-metal property in good standing. The property adjoins the Silbak Premier mine and has been mined in the past under agreement with Silbak Premier Mines, Ltd.

New Westminster.—The first carload of nickel concentrate was shipped on January 29 by Western Nickel, Ltd., to the Fort Saskatchewan, Alberta, refinery of Sherritt Gordon Mines, Ltd. Western Nickel is controlled by the Newmont Mining Corporation of Canada, Ltd., with Pacific Nickel Mines, Ltd., holding a 49% interest. The Granby Consolidated Mining, Smelting and Power Co., Ltd., is managing the mining and milling operation and will receive a participation in operating profit.

Lillooet.—During the final quarter of 1957 Bralorne Mines, Ltd., produced 21,103 oz. gold, valued at $738,605 ($35 per oz.), from 34,612 tons of ore averaging 0·61 oz. of gold per ton. On the basis of quarterly returns and

subject to adjustment the year's aggregate production was 89,115 oz. gold, valued at $3,119,025 ($35 per oz.), from 141,192 tons grading 0·63 oz. per ton.

Gold production of Pioneer Gold Mines of B.C., Ltd., for the three months ended December 31, 1957, was estimated at 12,897 oz. after the treatment of 27,033 tons of ore. The value of production was $439,834, with gold bonus estimated at an additional $30,000. After operating expense and provision for all write-offs excepting outside exploration the net profit was $22,284. In the nine-month period to December 31 (Pioneer's fiscal year commenced on April 1) the company recovered 32,099 oz. of gold, valued at $1,420,145, from 80,737 tons of ore; estimated gold bonus was $90,000. Gross operating profit was $297,287 and net profit, after provision of $131,168 for depreciation and depletion, was $166,119.

Kamloops.—The American Smelting and Refining Co. has acquired an option on the Highland valley copper prospect of Minex Development, Ltd., and is to proceed with an exploration and development programme during 1958. It is significant that with few exceptions all the principal properties in the Highland Valley are now held by the three largest United States copper producers—Asarco, Phelps Dodge Corporation, and Kennecott Copper Corporation. The notable exceptions are the very promising property of Craigmont Mines, Ltd., which is responding favourably to development by Canadian Exploration, Ltd., a wholly-owned subsidiary of Placer Development, Ltd., and the Trojan group which is now under intensive underground development by Trojan Consolidated Mines, Ltd. All work, as recently reported by Highland Valley operators, has indicated a considerably higher grade of copper ore than was originally found in the area.

Revelstoke.—American Standard Mines, Ltd., expects to assign the further development of its promising lead-zinc prospect, the River Jordan property, to a major United States mining and smelting company. Directors of the two companies have verbally agreed on the deal and it is expected a formal announcement will be forthcoming in the near future. New York–Alaska Gold Dredging Co. holds a one-third interest along with American Standard in the River Jordan property.

Vancouver.—The Britannia Mining and Smelting Co., Ltd., carried out considerable exploratory work on the Howe Sound property of the McVicar Mining Co., Ltd., during the summer of 1957. The annual report of Surf Inlet Consolidated Gold Mines, Ltd., which owns two-thirds of the issued stock of McVicar, states that the operation has been " closed and winterized in anticipation of further development next summer." Under the terms of its option agrreement Britannia has relieved the McVicar company of liability for assessment work, taxes, and other expense.

Lardeau.—Sunshine Lardeau Mines, Ltd., earned $1,206,673 from the shipment of concentrates in the year ended October 31, 1957; other revenue consisted of $2,705 from interest. After transportation and treatment charges of $447,908 and operating expense of $603,729 the profit for the year was $157,741. However, after the provision of $252,111 for depreciation and pre-production expense and an additional imposition of $39,000 for 1956 Income Tax, the operation resulted in a loss of $55,370, without provision for depletion. The net operating loss, together with payment of $164,000 in dividends, resulted in a reduction of earned surplus to $360,993 at the year-end.

Golden.—The revenue of Giant Mascot Mines, Ltd., for the year ended September 30, 1957, consisted of $835,731 from mineral production and $8,766 from miscellaneous sources. Chief items of operating cost were mining, $492,952; milling, $174,763, and administration, $61,480. After incidental Hedley expense of $23 and outside exploration of $2,394, the net loss for the year was $20,805. This compares with a net loss of $29,392 in the previous fiscal year and a profit of $25,237 in the year ended September 30, 1955. The company has entered into a deal with the McPhail Engineering Co. of Tacoma to supply 100,000 tons of barite. This will be recovered from the tailing pond at Spillimacheen and re-treating the tailing in the company's mill. Mr. Henry L. Hill, the consulting engineer, estimates 350,000 tons of barite in the pond and has also estimated a net operating profit of $2·00 per ton on the sale to the Tacoma interests. The Giant Mascot company's annual meeting of shareholders was given to understand that barite has suddenly sprung into demand and that further orders are anticipated. It is possible, the meeting was told, that the mine may be re-opened for the principal recovery of barite with lead as a by-product.

TORONTO

February 25.

Gold Production.—The output of the gold mines of Ontario for November totalled 219,352 oz. of gold and 37,737 oz. of silver, valued at $7,441,702, from 756,495 tons of ore milled. In December 750,537 tons was treated, yielding 215,462 oz. of gold and 44,230 oz. of silver, worth $7,494,289. The Provincial Department of Mines "Gold Bulletin" for December reports that during 1957 Ontario's 30 producing gold mines reported milling 8,977,583 tons of ore which contained 2,527,806 oz. of gold and 422,106 oz. of silver which had a total value of $85,293,143. In 1956 there were 32 producers which treated 8,986,725 tons of ore containing 2,474,944 oz. of gold and 407,242 oz. of silver valued at $85,446,209.

Blind River.—In December last the first shipment of concentrates was made by Northspan Uranium Mines from the Lake Nordic plant. It is stated that this plant is treating 2,000 tons of ore daily, but construction work on the second 2,000-ton unit is well in hand. In the same area the Panel plant is expected soon to be in operation, with the Spanish-American to follow.

Manitoba.—It has been reported that a new company—Strannar Mines—has been formed by Gunnar Mines and the Strategic Minerals Corporation of New York to develop extensive chromite deposits in the Cat Lake–Bird River area of south-eastern Manitoba. It is believed that exclusive rights to use the Udy process to treat the low-grade ores have been acquired.

Quebec.—The October gold output from Quebec mines has been reported as 88,185 oz., bringing the total for the first 10 months of 1957 up to 840,185 oz., which compares with 874,147 oz. for the corresponding period in 1956. October silver shipments totalled 288,462 oz., making the same 10-month period output 3,033,749 oz., against 3,514,144 oz. in 1956. The October output of asbestos is given as 84,653 tons.

The Mines Minister for Quebec has provisionally estimated that the Province's mineral output for 1957 will exceed $420,000,000 in value, of which iron ore and asbestos will provide over $185,000,000, copper about $66,000,000, and zinc $17,700,000. The titanium output for 1957 is estimated as $9,100,000 and that of calcium as $3,800,000.

The new four-compartment shaft at Campbell Chibougamau Mines at Cedar Bay has been completed at 1,121 ft. and lateral work is planned at the 250-ft., 550-ft., and 650-ft. horizons. The known reserves on this mine have been estimated as 222,263 tons grading 1·85% copper with 0·10 oz. of gold and 0·60 oz. of silver per ton down to 650 ft., with 316,000 tons of additional ore "probable" down to 900 ft. The mine should be in steady production early in 1958.

It was announced in January that shareholders of the Eastern Mining and Smelting Corporation, Nickel Rim Mines, and Canalask Nickel Mines had agreed to amalgamation and at the same time to purchase the mineral rights and leases of Trebor Mines. The new company is to be known as the Nickel Mining and Smelting Corporation and will have a capital of $7,000,000 in $1·00 shares.

The Quebec Lithium Corporation, it has been announced, is to go ahead with the erection of a refinery and chemical plant in New York State at a capital cost of some $3,000,000. The new plant, scheduled for production in 1959, will at first manufacture only lithium compounds, although later lithium metal may be produced. At present the Corporation's 1,000-ton-a-day mill at La Corne ships its concentrates to the Lithium Corporation of America on a five-year contract.

MELBOURNE

February 20.

Lead-Zinc Enterprises.—The increasing incidence of falling metal prices on the affairs of the Broken Hill and other lead-zinc producers has been evident for some time. In 1957 there was increase in the output of silver, lead, and zinc on the Broken Hill field, all mines being in a position to raise output, and lower-grade ore was worked. The present position was foreseen by the companies and anticipated to a moderate extent by the share-market. At the beginning of the current year stockpiling on the mines of lead and zinc concentrates by Zinc Corporation and New Broken Hill Consolidated was announced, while a recent statement by the four Broken Hill mining companies advises that output will be cut by 10%, or one working day per fortnight, a decision which caused no surprise. There is no indication as yet whether grade of ore mined will be affected, but it is inevitable that the position will influence ore reserves

and the grade that can be economically mined and milled, necesitating exclusion of blocks of ore from calculations. It is understood that Mount Isa Mines, Queensland, will make no change in the scale of their operations and that plans for expansion and the rate of production will be unaltered. The extent to which this work was to be financed from profits will be reduced and additional capital raised to compensate.

The high efficiencies built up by these two big groups of mines, their standard of mechanization, and the high level of recoveries, together with the large scale of working, have ensured a very satisfactory cost position, all making for profitable operation though at a lower level. The Broken Hill companies, in particular, have very solid investments which is an important factor from the shareholders' viewpoint. E.Z. Industries (Electrolytic Zinc Co. of Australasia), which has been gradually increasing production of metallic zinc at its Risdon works from concentrates from Broken Hill and from its own Tasmanian mines must feel the recession in price but will be helped by its by-products—superphosphate and sulphate of ammonia—which have reached substantial tonnages. Hardest hit will be Lake George Mines, where ore-bodies are shrinking with depth and the fall in metal prices is stated to have made a difference of some £A600,000 in profits. The position at that centre has been put to employees, stressing the need for full co-operation if the mine is to be kept working, for the ore position is such that a shut-down might raise a serious problem in re-opening.

Hill 50.—Rather more than usual interest has centred in this rich gold mine, at Mount Magnet, Western Australia. After a more or less borderline career a high-grade ore zone was reached below the 700-ft. horizon some five years ago, values were phenomenal, and mining conditions particularly favourable. Grade of ore, for a considerable time, was 13 dwt. to 14 dwt. gold per ton and the output approximately 9,000 tons per four-week period. Dividends paid have reached £A3,900,000. Recently the position was disturbed by reports to the effect that ore reserves had been overestimated and that there had been a reduction in tonnage from 843,000 tons to 713,000 short tons, while closer development work between the 1,060-ft. and the 1,304-ft. levels had also caused a reduction in grade to 12 dwt. gold per ton. In the last financial year the company earned a net profit of £A922,544 and in order to maintain the profit position work is in hand to increase mine output and mill capacity to 12,000 tons of lower-grade ore per four-weekly period. It is reported that the lode below the bottom level is satisfactory in dimensions. Prospecting at depth will be continued and new work has been commenced in the north end of the mine, hitherto regarded unfavourably from a prospecting viewpoint.

Oil.—The search for oil still continues with little encouragement. West Australian Petroleum Pty., Ltd., has decided to cease drilling in the Carnarvon Basin, in Western Australia, which includes the Rough Range, Cape Range, and Learmonth areas. Since the first well drilled at Rough Range discovered oil in December, 1953, at a depth of 3,605 ft. the company has drilled 22 wells in the area at a cost of £A6,400,000 and has spent £A12,915,000 on the search for oil in the State. The company intends to continue exploration, but will concentrate its efforts in the Kimberley region, in the North-West. The change of locality will be made as soon as Learmonth No. 1 well at Exmouth Gulf, in the Carnarvon Basin, now at a depth of 7,622 ft. is finished. Detailed seismic work is being carried out in the Kimberleys to locate suitable drilling sites. The first deep exploratory well will be drilled in the Canning Basin and the Fitzroy Basin is also included in the priority areas.

In Victoria the Woodside (Lakes Entrance) Oil Co. has suspended drilling at a depth of 4,013 ft. in unfavourable formation, but survey parties are to continue working in the Gippsland country and also in the Murray River Basin in the north-west of the State.

Santos, Ltd., has done a considerable amount of work in northern South Australia and across the border into Queensland in the Great Artesian Basin; at the present time the company's engineers are conferring with United States authorities on results obtained to date and concerning the future activities of the company.

Two companies in association are working in the Gulf of Carpentaria country. In New South Wales, drilling has been in progress within a distance of 100 miles from Sydney, with natural gas as the objective; discoveries have been made but no accumulation in commercial quantity has been reported. Australian interests are drilling in Timor, in country where seepages were stated to exist. The work has been slow and the

No. 1 well has passed a depth of 4,000 ft. At June 30, 1957, expenditure had reached £A127,200. It is considered that the target will be reached in 18 months. Australasian Petroleum Co. Pty., Ltd., and Island Exploration Co. Pty., Ltd., drilling in Papua, have reported substantial flows of gas from the Barikewa well at a depth of 8,025 ft. The associated overseas companies have announced their intention to limit the degree of financial assistance to be provided.

Manganese.—A matter of importance to the Australian steel industry is the supply of manganese ore, particularly in view of the steady expansion in the production of steel, which has now passed 3,000,000 tons per year. Reserves of manganese have always been limited and interest in prospecting and mining of the ore has also been limited. In order to encourage the search for ore of metallurgical grade the Government relaxed the total ban on the export of ore at a time when reserves were 545,700 tons, a tonnage that would have been exhausted by the end of 1960. Since the export of a limited quantity has been permitted prospecting has been stimulated and reserves have been increased by 139,550 tons to a total of 744,450 tons. While this is still inadequate the increase is satisfactory and the stimulated activity is likely to continue, so that it may, ultimately, be possible to bring manganese reserves into the required proportion to the reserves of iron ore and eliminate the need for importation of ore.

Gold.—Gold production in Western Australia, in the 12 months to December 31, 1957, increased by 84,000 oz. over the previous 12 months, the total figure reported for the year being 896,683 fine oz., valued at £A14,038,185 ; for 1956 production was 812,706 oz. The State's total gold production has now reached 59,045,716 fine oz. with a value of £A403,203,600, which includes the sum of £A1,197,460 obtained from premium sales by the Gold Producers Association since its formation in 1951. The 1957 gold output was assisted by a large increase in December, when 116,890 fine oz. was produced compared with 65,032 fine oz. in the same month of 1956. The reason for the increase is that some mines on the Golden Mile, Kalgoorlie, cleaned up twice during the month. For the first half of the current year production may be affected by the expected lower grade of ore milled by Hill 50 Gold Mine and before the increased mill throughput can compensate for the decrease in yield.

Victoria's gold yield for 1957 was 48,205 fine oz., an increase of 5,809 oz. on the previous year's total. There has been no new production to account for the increase, but developments in two of the few operating mines have permitted an increase in the rate of mining.

Copper.—In the half-year ended December 31 last Mount Lyell Mining and Railway produced 24,865 tons of copper concentrate, an increase of 9,250 tons that was due partly to a rise of 23% in throughput and partly to a considerable improvement in the grade of ore mined. In the six months period the mill treated 1,014,294 tons of ore, as compared with 827,913 tons in the first six months of the 1957 period, production of blister copper rising from 4,017 tons to 5,476 tons. Most of the ore in the 1956–57 period came from an impoverished zone near surface which would not continue at lower depths. Mine and treatment plants were fully and efficiently equipped and the new crusher and transport system was well advanced. Results from the open-cut since June were regarded as entirely satisfactory in tonnage and grade of ore.

Northern Territory.—After the years of depression that followed the mining boom in the early part of the century, when much money was spent to little purpose, the Northern Territory is again coming to the fore as a metalliferous province. Value of the mineral production, exclusive of uranium, in the year to June 30 last was £A3,319,000, as compared with £A3,303,000 in the previous year. The position was affected by the steady fall in the price of copper and its influence on returns from Peko Mines, N.L., which is the Territory's copper producer. There have been important increases in the output of gold and silver and in the tonnage of copper ; production of wolfram, mica, and manganese decreased. Production figures for the Rum Jungle uranium enterprise for the period have also been released and amounted to 541,652 lb. of uranium oxide ; in addition to this production uranium minerals from other sources were valued at £A475,000.

There is considerable activity by large mining organizations in prospecting for lead-zinc and iron ore in the Territory. A large deposit of the former is being examined by Mount Isa Mines and Broken Hill Proprietary has for some time been prospecting a large iron-ore deposit on the Territory–Queensland border. It has recently been reported that a concession covering an extensive bauxite

deposit has been granted to an overseas group, while United Uranium, King Island Scheelite, and Loloma Gold Mines, operating in conjunction, are exploring the Maranboy tinfield, south of Katherine. This field was worked for a number of years, with the aid of a Government battery, by working parties. The present lessees hold leases or options covering most of the field and reports of exploratory results are encouraging. Sinking has reached a depth of 170 ft., with an objective of 250 ft. At the 125-ft. level the lode was cut in a cross-cut 17 ft. wide and assaying 1·75% tin oxide. Discoveries are likely to be made further north where work is in progress east of Brock's Creek. Because of the greatly increased demand for tin caused by the commencement of tinplate production at Port Kembla, New South Wales, by Broken Hill Proprietary active prospecting for tin should be an important factor in Australian mining.

Peko Mines, it is stated, still maintains its normal rate of production and in the period ended February 5 produced 9,775 tons of ore and recovered 2,494 tons of concentrates assaying 24·79% copper with 7·8 dwt. gold per ton. The main shaft is at a depth of 1,013 ft. and preparations have been made to open out a new level. The mine can be regarded as a high-grade copper proposition with very helpful gold values. Ore reserves are close to 1,000,000 tons, but the company is hampered by the necessity to consign concentrates over 2,000 miles by road, rail, and sea, to the smelters at Port Kembla. Smelting at the mine offers a difficult economic problem because of long distances for transport of essential materials.

Western Australian.—The State Government wishes to extend the charcoal iron industry now operating at Wundowie, about 50 miles east of Perth. The ore deposits are not large, but collectively might build up a satisfactory commercial enterprise. Ore deposits in the south-west of the State have been considered suitable for the enterprise and the Premier has stated that the Government will consider any proposal by private interests to participate in a charcoal-iron industry in that part of the State. Finance is a major problem and an approach was made to the Federal Government for a permit to export 1,000,000 tons of iron ore from the Koolyanobbing deposit to Japan, to provide the finance for the development and equipment of the charcoal-iron project in the south-west. The request was refused because Australia's iron-ore reserves, although reasonably large, do not offer the tonnage desirable for long term operation. A new request is to be made to the Federal Government for permission to export 1,000,000 tons of iron ore from a deposit near Mullewa to finance the industry.

SINGAPORE

February 9.

Tin Quota.—The steps recently taken by the International Tin Council to control production means that Malayan producers must face a cut of some 40%. Commenting on the decision Mr. Woo Ka Lim, nominated mining member on the Federation of Malaya's Legislative Council, said the market would be stimulated, "but there is no denying the fact that the miners will be very hard hit by the new restrictions." He added, however, that "these drastic measures are necessary if we are to save the situation from total collapse." Many Chinese mines will have to stop production for the second half of March when no export quota will be available and when production is resumed for the quota period beginning in April, fewer workers are likely to be engaged in view of the further cut.

In an annual trade review, Mr. Henry Wong, secretary of the Associated Chinese Chambers of Commerce, in Kuala Lumpur, attacks the International Tin Agreement and suggests that Buffer Stock buying should be shifted to Singapore to offset the "unfavourable" London market and that, the stabilizing tin price level should be lowered to come within the economic compatability of the consumer countries in order to discourage countries behind the Iron Curtain from dumping more tin on to the world market. To help the country's tin miners to solve the present crisis he suggested, *inter alia*, that the Government should take over from tin miners the financial burden of the Buffer Stock contributions and should consider the question of producing tinplate in Malaya. Mr. Wong's criticisms have been strongly rebutted both by Mr. Woo Ka Lim and by Mr. J. T. Chappel, for the Malayan Chamber of Mines, the latter saying that :—"Until the last part of 1957 the industry benefitted substantially from the agreement, which undoubtedly maintained the tin price at a higher level than if there had been no agreement. Owing to circumstances outside the Government's and industry's

control the tin market deteriorated rapidly towards the end of last year, and drastic measures have had to be taken by the International Tin Council to rectify the position. Malaya, as the largest tin producing country, must play its full part in supporting the council.

"Main aims of the agreement were to: Prevent or alleviate widespread unemployment; prevent excessive fluctuations in the price of the metal; achieve a reasonable stability of price on a basis which would secure long term equilibrium between supply and demand; and ensure adequate supplies of tin at reasonable prices at all times."

Kelantan.—Inche Hashim bin Mar Dris, Kelantan's Adviser on Lands and Mines said recently that the main difficulty facing the State's mineral development was communications. Mining in the old days had been abandoned because of transport difficulties and the Government proposed therefore first to open areas close to railway lines so that intending miners would not have to spend much money on building roads. Miners, however, must comply with the condition that at least 50% of the unskilled labour engaged must be subjects of the Sultan of Kelantan.

Pig-Iron.—The Perak Iron Mining Co., Ltd., is to negotiate with Australia through the Colombo Plan to supply the technical knowledge to operate a pig-iron plant which the company plans to set up at Damar Laut next year, according to a Kuala Lumpur report. Mr. Ng Hong Heng, a director of the company, is quoted as saying that the plant, the first of its kind in the country, would make use of the iron ore from the company's mine south of Ipoh. The firm would also establish a plant to produce charcoal by-products.

Lead Discovery in Pakistan.—Following a find in the Ushu Valley, an official of the Pakistan Mineral Exploration and Research Association stated recently, a Pakistani company has been authorized to exploit a mine. Work should get into full swing when mechanical equipment was acquired. The mine is considered a commercial proposition even though about 50 sq. miles of the area of the Ushu Valley is inaccessible by road in winter because of snow.

Geological survey work in both wings of Pakistan is now being expanded with a view to making discoveries of minerals. Along with the programme for intensified survey an ambitious project aimed at developing and modernizing the mining industry is being taken in hand by the Central and Provincial Governments and allied agencies.

Assam.—The Indian Government and the Assam Oil Company, it is announced, have signed an agreement to form a company to seek and produce oil in upper Assam. Under the agreement two-thirds of the capital of the new company—Oil India Private, Ltd.—would be provided by the Assam Oil Company and one-third by the Indian Government.

IRELAND

February 19.

Copper.—Operations by Canadian interests at the Allihies group of mines in Co. Cork continue to make good progress and the unwatering of the Mountain mine has reached 750 ft.—*i.e.*, about halfway to bottom—the grade of ore continuing to improve at depth.

At Avoca mines, Co. Wicklow, the company states that plant and equipment should be completed by July, when production is expected to begin. Some 450 men are now employed and about 100,000 tons are stockpiled on the surface. Concentrates will be sent to the Continent to be smelted. It is stated also that despite the present low price for the metal the company's programme will go ahead as arranged.

Lead and Zinc.—Production figures for Silvermines Lead and Zinc for the year ended March 31 last show that the ore treated totalled 97,998 tons, yielding 1,449 tons of lead concentrate. Ore reserves at March 31 last are given as: Proved, 535,091 tons, averaging 1·94% lead and 1 oz. of silver per ton; partly proved, 443,399 tons, averaging 1·56% lead and 0·9 oz. of silver per ton. For the three months ended December 31, 35,778 tons of ore were treated to produce 453 tons of concentrate averaging 65·5% lead and 31 oz. of silver per ton. The company has stated that owing to the continued low price of lead and the persistant low grade of ore mined production was suspended as from January 4, 1958. A programme of underground exploration and development is being carried on.

St. Kevin's Lead and Zinc Mines, Ltd., has stated that owing to the fall in metal prices further exploratory work at Glendalough mines, Co. Wicklow, is not contemplated at present.

Iron.—Good deposits of iron ore are known to exist in Co. Leitrim, but in order to develop them effectively modern scientific processes are needed which are not yet available in this country.

Coal.—Satisfactory progress is being made with the equipment of Drumglass mine, in Co. Tyrone. The importance of increasing the meagre output of coal in Ireland cannot be overstressed. In 1921 a Commission investigated the mineral resources of Northern Ireland and considered that in East Tyrone and under Lough Neagh there must be some 57,000,000 tons of coal per square mile. It stated, however, that the whole area was faulted badly and covered largely with overlying clay. Every effort is now being made to encourage the enterprises at Congo and Annagher.

General.—The effect of base-metal prices in recent months has been the suspension of exploration operations at many mining enterprises. This is a great disappointment from the view of the national economy because most of the finance and the technical supervision needed were being provided by outside sources. However, sufficient work has been done to show that given reasonable prices for the metals there are considerable mineral deposits which are worthy of close attention.

JOHANNESBURG

February 27.

Gold Production.—Including a "miscellaneous" output of 490,820 fine oz. gold production in 1957 advanced to the record level of 17,031,637 oz., from the 1956 figure of 15,892,935 oz., which included 519,255 oz. of miscellaneous output. Against the general economic background particular interest attaches to the cost structure and trends in the industry. Through 1957, as compared with 1956, 10 out of 31 gold producers reduced working costs per ton and the same proportion their costs per oz.; 8 out of 23 gold-uranium producers reduced their working costs per ton and 11 of the 23 their costs per oz. Mainly higher costs were recorded by the others.

Recruits for the Mining Industry.—Mr. W. D. Lyle, general manager of South African Land and Exploration, has been elected president of the Mine Managers' Association for the ensuing year and Mr. E. M. Stewart, general manager of West Rand Consolidated Mines, vice-president. The outgoing president, Mr. F. C. Steinhobel, commented that the Government Miners' Training Schools on the gold mines are still not attracting the numbers of trainees which are required from the domestic population, while recruiting in Europe was becoming more difficult owing to the economic recovery there and was presently confined to Holland and Italy and to a less extent Western Germany. The numbers of trainees at the schools had declined to 1,406 in 1957 from 1,598 in 1956 and 1,444 in 1955, of which overseas recruits were represented respectively by 799, 1,049, and 884. Recruits of learner officials had declined to 182 in 1957 from 344 in 1956, the decline being ascribed to raising the standard required and to competition from secondary industry.

Mineral Traffic.—The general manager of the South African Railways has reported that among the highlights of 1957 was the movement of iron ore from the North-West Transvaal and North-West Cape to the Pretoria and Vereeniging steelworks and of coal, including the maintenance of adequate coal stocks at all power stations. The total tonnage moved at 75,031,000 tons reflected a small advance in 1956–57 on the previous year, while from April to September, 1957, the tonnage of 56,012,000 was 943,000 tons higher than the previous corresponding figure. Due partly to the programme of expansion the railways are not yet able to accept all the traffic on offer and of coal in particular. The shortage of traction power was again evident last year and, partly at any rate, results from a cautious buying policy against the background of investigations into and actual conversion to electrification of certain zones and into the introduction of diesel traction on a substantial scale. The use of additional truckage purchased has been limited by the traction shortfall.

Platinum.—Rustenburg Platinum Mines has reported that the factors in oil processing techniques reducing intake of platinum per barrel capacity include a lower installed weight of the metal—namely, a lower-grade platinum alloy, improved techniques, longer life of the platinum catalyst, and accumulated stocks of the metal held by the refiners; in addition, greater supplies have been made available from Russian sources. These factors rendered incorrect the assessment by the company of the oil industry's platinum requirements for the period ended 1960 and

have made the extensions of the Rustenburg 1956–57 programme unnecessary, at any rate for the time being, so that additional plant capacity will not immediately be commissioned. Furthermore the company is scaling down output to levels which will result in reduced stocks in the pipeline to the refinery and of refined metal. It is considered unlikely that sales will be reduced below 50% of the 1956–57 levels. Under present conditions operations will be mainly conducted at the Rustenburg Section, to which certain items of underground equipment will be transferred. The company is considering raising loan funds to cover the deficit in funds in the 1956–57 year and the balance of the capital expenditure to be outlaid in the 1957–58 year, to relieve the strain on the appropriation account until accumulated stocks are reduced or sales increase again.

Transvaal.—In the final 1957 quarter output of fibre by Msauli Asbestos Mining and Exploration at 2,626 tons (2,627) brought in £143,980 (£152,566), the lower revenue being only partly offset by the reduction in working costs to £91,717 (£95,159). The estimated profit was therefore lower at £52,263 (£57,407). The new hydro-electric plant has been fully commissioned and is meeting all requirements.

Rooiberg Minerals Development, in the final 1957 quarter, recovered 274 long tons of tin concentrates from a total of 38,289 tons treated in both the main and rough concentrators, against 290 tons of concentrates from 38,711 tons treated in the third quarter. The estimated profit declined to £16,744 from £23,138 and capital expenditure was increased slightly to £18,626 from £18,415.

S. A. Minerals Corporation is to suspend chromite output from mid-March owing to the continued weakness in the chromite market.

Afrikander Proprietary Gold Mines has sold its coal option and prospecting contracts in the Wakkerstroom and Utrecht districts to one of the leading mining houses, has been refunded all costs and expenses involved, and will retain 10% subscription and underwriting rights in any company formed to exploit the area as well as royalties on all coal sold. A drilling programme is planned.

Witwatersrand Brick and Tile has embarked on a programme of extending its activities. It has acquired a 50% interest in Springbok Industrial and Mineral Ventures (Pty.), Ltd., which owns a lease over a large, high-grade iron-ore deposit not far from the Postmasburg Station. It has also purchased the controlling interest in Minerais Basicos de Mocambique Limitada, which owns concessions at the mouth of Pebane River in Portuguese East Africa, including a high-grade titanium deposit, and to which an interest-free loan of £40,000 has been advanced. In turn, a London company has acquired from the Witwatersrand company half the latter's interest in the Mocambique company, to which it has advanced an interest-free loan of £100,000. Production of titanium concentrates is expected to be initiated in the near future. In order to ensure regular coal supplies the Witwatersrand company has acquired coal rights in the Ermelo district and has already commenced production.

Orange Free State.—Western Holdings has completed its No. 3 twin-shaft system in the western section of the lease area. The circular, 18 ft. diameter, ventilation component was sunk 3,718 ft. in 10 months ; the hoisting component, 24-ft. in diameter, was sunk 3,864 ft. in 12 months. Sinking methods included the use of the Blair sinking-stage hoist. The gold plant capacity is being extended from 125,000 to 150,000 tons a month, with the extensions expected to be commissioned after about the year-end. The additional capacity will handle the increased ore tonnage from the western section which may on average be of a higher grade than originally anticipated. Basal Reef intersection in the No. 3 Shaft disclosed values of 3,264 in.-dwt. Up to the present the mine has been milling a grade lower than what is considered to be representative of the lease area, due to the high proportion of development ore included in the mill feed and to the extent of primary development so far accomplished.

Loraine Gold Mines has reported that the Anglo American Corporation has not exercised its right to subscribe for 2,750,000 reserve shares, which right lapsed at the end of 1957. The company has stated that if B Reef development can be improved, the tonnage milled raised to 75,000 tons a month (the January tonnage milled was 63,000 tons), and reef development maintained at last year's footages, the continuation of operations was justified. However, recent results have not reflected a trend in that direction. Reef development is being advanced on the Basal, B, and so far to a

limited extent in the south-western section on the multiple conglomerate band of the Elsburg Series. The latter, however, are not thought to extend into the lease area to any great extent.

President Steyn Gold Mining is conducting limited stoping on the Leader Reef horizon, where relatively high uranium values have been disclosed, while the effect on the overall gold grade is being offset by surface waste sorting.

Benefits in respect of the effect on taxation of the pre-production and post-production capital expenditure are now diminishing and President Brand Gold Mining will become liable for taxation at a gradually increasing rate from about the beginning of 1959. Post-production capital expenditure continues at a high level on a programme of expansion that aims at raising the milling rate by about 31,000 tons a month to 100,000 tons not long after the end of the current year. The increased tonnage to be treated should offset, at least considerably, the impact of taxation and lease payments on profits available for distribution. The above programme of expansion will complete in effect the second phase of developing the mine; the third phase will consist of opening up the south-eastern section, involving the sinking of a joint twin-shaft system with the neighbouring President Steyn mine, and raising the treatment rate to the full capacity of the plant—namely, 125,000 tons a month.

Cape Province.—O'Okiep Copper has announced the completion of the company's programme of expansion to an ore production rate of 150,000 tons a month. However, owing to copper price and output trends, production for the time being will be maintained at 125,000 tons a month of ore or about 83% of capacity.

General.—In addition to its gold shareholdings in Witwatersrand companies, in the Klerksdorp and Free State fields, in the diamond-mining industry, and in the copper mines of Northern Rhodesia through its investment in Rhodesian Anglo American, the Rand Selection Corporation, Ltd., through its participation agreement with the Anglo American Corporation secured shareholdings in Forest Industries and Veneers, Ltd.—which has acquired as wholly-owned subsidiaries Peak Timbers, Ltd., Veneered Plywoods (S.A.) (Pty.), Ltd.—Rand American Investments (Pty.), Ltd., and Western Deep Levels, Ltd.

Col. Jack Scott has purchased an Alouette helicopter for prospecting operations in Basutoland.

Free State Saaiplaas is not proceeding at this stage with its issue of reserve shares to raise additional capital.

The Transvaal and Orange Free State Chamber of Mines has granted the Witwatersrand University £8,000 a year over 10 years to establish and maintain a post-graduate school and research unit in economic geology.

South West Graphite Mining and Refining is changing its name to the Rand London Corporation, Ltd., which suggests that an extension of activities is envisaged.

Jet-type pumps are extensively used in the mining industry. Accordingly considerable interest is attached to the design of a jet pump employing compressed air, as developed by mechanical engineering division of the South African Council for Scientific and Industrial Research, for experiments on the pneumatic conveyance of granular materials.

Union Lime, which operates works at Ulco, in the Barkly West district, will largely complete its programme of expansion in the 1957–58 year, in which two additional kilns have already been installed together with ancillary equipment and extensions effected in the hydration section. Like Northern Lime, which, *inter alia*, also supplies the uranium plants, capacity output has been retarded by railway restrictions. These are expected to be eliminated in the near future.

Bechuanaland

A delegation from the Bamangwato Tribe now in London announces that negotiations have been taking place with the Rhodesian Selection Trust in connexion with proposals for the grant of a mineral prospecting concession over the Tribal Areas of the Bamangwato, in Bechuanaland. The negotiations have been satisfactory and, after discussion with the Commonwealth Relations Office, are to be continued in Africa. The delegation, headed by Chief Rasebolai and including Chief Tchekedi Khama and Chief Seretse Khama, was accompanied by the consultants to the Bamangwato Tribal Authority, Messrs. Mackay and Schnellmann.

Trade Notes

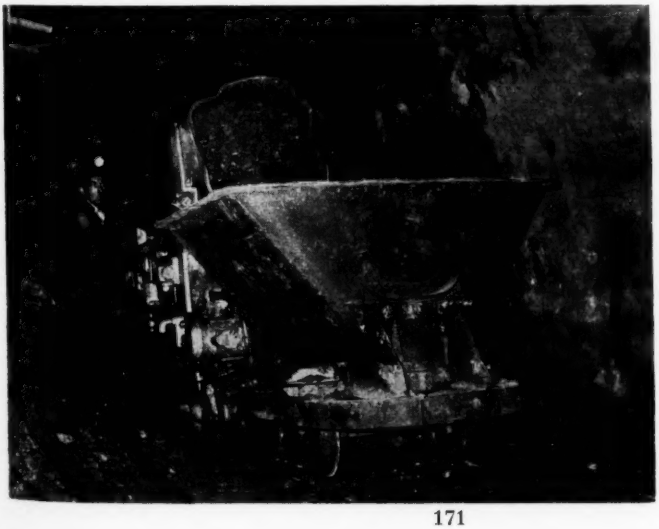
Brief descriptions of developments of interest to the mining engineer

New Rock-Drills and Loader

At an underground demonstration recently staged in the Riber mine, Matlock, **Atlas Copco (Great Britain), Ltd.,** showed two new rock-drills and a compact new loader of their manufacture. The compressed air for this mine is supplied by an Atlas Copco AR4 type compressor, which delivers 760 c.f.m. at 90 p.s.i. and has been operating satisfactorily for three and a half years.

The first drill shown, now introduced to the British market after, it is stated, tests abroad for more than a year, was the BBC22 WK (the " Lion "), fitted with a new pusher leg type BMT 50. Designed for working in large tunnels or mines where holes from 10 ft. to 90 ft. are to be drilled the drill is claimed to be a very fast machine for its weight. It weighs 66 lb., its normal working air pressure being 85 p.s.i., although by a slight modification it can operate at 60 p.s.i. Drilling speed in sandstone is said to be 3 ft./min. with a working pressure of 85 p.s.i.; at the same pressure the average drilling rate in shale is 4 ft. to 5 ft./min. using a 43-mm. (1·7-in.) bit in both cases. Although intended for use with the BMT 50 pusher leg it can be accommodated to chain and screw feed equipment or modified to a sinker. When used as a sinker, however, it is recommended that the Lion should be used with a counter weight to minimize recoil. The machine is simple in operation as it has been designed so that all necessary controls are on the back head and the handle. It is thus possible to start the feeding, then the flushing, and, finally, the drill with the same throttle lever, while by a second back head lever the feed pressure of the pusher is adjusted. Since from the back head the air is fed through channels to the cylinder and the pusher the air hose for the pusher has become redundant. Lubricated by a BLG line lubricator the standard " Lion " is supplied with a rotation chuck for $4\frac{1}{4}$ in. by $\frac{7}{8}$ in. hexagon collared shank, the bore and stroke of the machine being $2\frac{3}{4}$ in.

The second drill is a light-weight type,



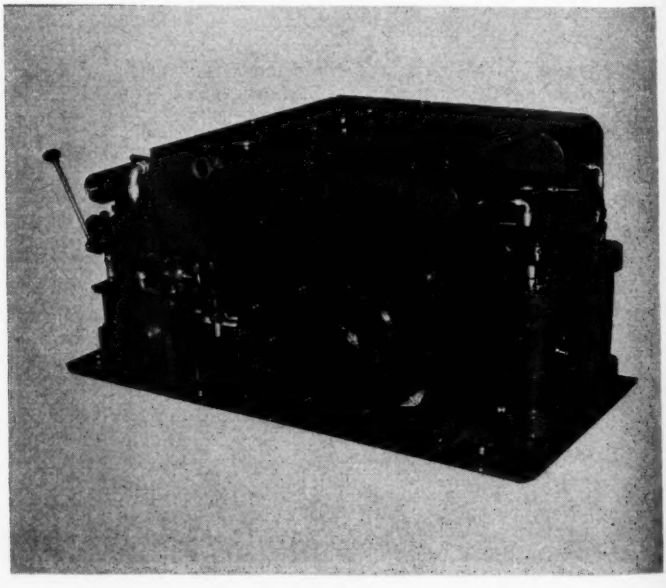
LM 56, Digging on the Dip.

BBD 12 WH, based on the original BBD 11 WH and mainly designed for small drilling operations where drill speeds are not of prime importance and light weight and economy of compressed air are the main considerations. It is a water flushing machine equipped with a new type of drill steel holder with rubber buffer, the rotation chuck being completely covered by the lower head. In addition to the standard rotation chuck for $\frac{3}{4}$ in. by $4\frac{1}{4}$ in. drill steel shanks a chuck for $\frac{7}{8}$ in. by $4\frac{1}{4}$ in. steels can be supplied. The water flushing is synchronised with the air supply to the rock-drill in order to prevent dry collaring.

The LM 56 loader, shown here digging on the dip, is intended for use in tunnels (7 ft. to 8 ft. wide) and a minimum height of 7 ft. The LM 56 has a total motor power equal to 10 h.p. per ton machine weight and 10·4 h.p./cu. yd. bucket volume, a contributory factor to its 4,400 lb. digging capacity being the positioning of the cradle shaft, which enables the bucket to penetrate easily into the rock pile. To reduce the sound of the machine its bucket and traction motors have been fitted with special silencers, while special silencers at the air controls have also been built in for the exhaust air. By mounting a suitable winch on the back of the loader and having the air supply to the winch and traction motor of the loader interlocked through the traction motor control it is ensured that raising and lowering of the loader is at all times positive and independent of the adhesion between wheel and track. The LM 56, which is 57 in. wide and 88 in. over all and 85 in. high with bucket extended weighs 6,500 lb.

Automatic Hydraulic Haulage Gears

A recent development in the design of Pickrose haulage gears made by **Austin Hopkinson and Co., Ltd.,** of Audenshaw, Lancs., has been the incorporation of a fully-automatic hydraulic power transmission, made by Vickers-Armstrongs, Ltd., and known as the V.S.G. (variable speed gear). The machines are available in three sizes—H1, which is illustrated, for 5,000 lb. pull, H2 for 15,000 lb., and H3 for 25,000 lb. The drive consists of a constant-speed flame-proof electric motor coupled to a pump unit which delivers oil at pressure through a control valve to the hydraulic motor, the output shaft of which is coupled to the reduction gearing of the hoist proper. The pump is a pressure-controlled unit and will deliver its maximum capacity up to and including a predetermined pressure setting. Any increase in the working pressure above this setting will cause the pump to reduce capacity (and capacity will vary inversely as



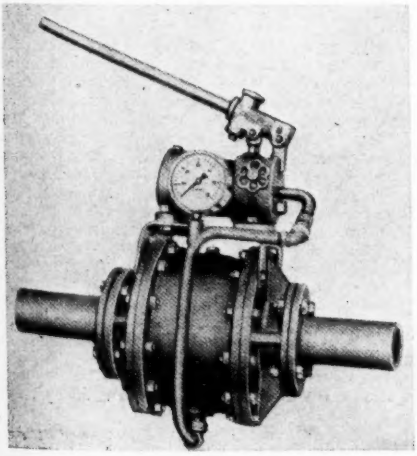
"Pikrose" Automatic Hydraulic Haulage.

the pressure rises, until at maximum pressure the pump delivery is zero), while maintaining maximum pressure on the system. Since the fluid horsepower is a product of the capacity times the pressure it follows that at zero capacity the fluid horsepower is zero and the input horsepower is that required to drive the pump at full speed *plus* leakage. Similarly if the control valve is open in either direction when this condition applies then maximum pressure is applied to the pistons of the hydraulic motor, giving maximum torque at no speed.

The control valve is of the open-centre four-way type specially developed for hoist control. The open-centre feature ensures that with the valve in mid position oil is circulated from the pump through the valve to the oil supply tank, the pressure being only that required to force the oil through the valve and the two short pipelines—*viz.*, pump to valve and valve to tank. This means the electric motor is running in the light load condition when the hoist is not in use and circulating the oil, so giving the maximum radiation cooling. The valve spool is spring centred so that release of the control handle causes the hoist to stop. The handle thus functions as a "dead man's" handle—*i.e.*, failing to safety.

Hydraulically-Controlled Rubber Valve

A rubber valve which is hydraulically controlled is now obtainable in this country through **Neldco Processes, Ltd.**, of Ashford, Middlesex. The rubber orifice is so designed that it can give a virtually circular orifice at all apertures. Described as a Krebs Sala valve the unit is claimed to give less loss of head due to friction than any other type of valve, since the section through the rubber bushing when pressed together takes the form of a venturi pipe. When used for pulp or similar fluids the valve is considered ideal, because the material does not build and plug the valve.



Personal

JOHN D. BARRINGTON, president and managing director of Ventures, Ltd., and a director of McIntyre Porcupine Mines, has been appointed president and managing director of the last-named company.

JOHN A'C. BERGNE has left for South Africa.

GUY FINLAYSON is shortly returning from Turkey.

S. V. GRIFFITH is returning from South Africa.

D. W. HANNAFORD is now in Burma.

J. W. NORTHROP is home from Northern Rhodesia.

B. J. RUSHTON has been appointed chemist to the Geological Survey Tanganyika.

R. C. SANSOM has been appointed an assistant geologist in British Guiana.

W. J. TRYTHALL has left for Sierra Leone.

M. L. URQUHART has been appointed vice-president operations of McIntyre Porcupine Mines.

S. M. WEDD has been appointed a director of McIntyre Porcupine Mines.

P. WESTERBERG has left on a visit to Southern Rhodesia.

JAMES LATIMER BRUCE, vice president, consulting engineer, and director of the Cyprus Mines Corporation, died suddenly on February 6, aged 77. Born in Dublin, Mr. Bruce entered the Colorado School of Mines in 1896 and was graduated in 1901 after having taken a year's leave between to earn sufficient to enable completion of his course. Until 1904 he worked for various firms at Cripple Creek as surveyor, assayer, draughtsman, and engineer, moving then to south-east Missouri to work for the Federal Lead Company, where he was in turn surveyor, chief engineer, and general mine foreman until 1907 when he went to Joplin for various companies and finally stayed with Continental Zinc Company as manager. In 1913 he became associated with Butte and the Superior Company which D. C. Jackling was developing, in 1919 becoming manager of the Davis-Daly Copper Co. at Butte where he remained until 1924, when he set up in a consulting practice in Salt Lake City. Then followed his long association with the Cyprus Mines Corporation, up to 1939 as manager and resident director in Cyprus and thereafter as vice president, consulting engineer, and director in the United States, during which time among many other duties he was responsible for the design of the

sulphuric acid autoxidation plant which was completed in Cyprus in late 1951. He was also closely connected with the affairs of the Pima Mining Co. and the Marcona Mining Co. Mr. Bruce was a Legion of Honour Member of American Institute of Mining and Metallurgical Engineers, and a member of the American Mining Congress and of the Engineers Club of Los Angeles. During World War II he served as consulting engineer for the War Production Board. Prior to Pearl Harbour he recommended to OPA the Premium Price Plan which was subsequently used for stimulating zinc production. In 1949 at the 75th Anniversary Convocation of the Colarado School of Mines, Mr. Bruce was awarded the Distinguished Achievement Medal.

Metal Markets

During February [1]

Copper.—During February there was yet another post-war free-trading low price for copper (£160 per ton as far as official closing prices are concerned, but with trading reported down to £159 10s.), which may be taken as evidence of the continued weakness of the market.[2] Some quite encouraging figures for U.S. consumption in January gave a brief fillip to sentiment, while the successful launching of a U.S. earth satellite early in the month was not without its re-assuring effect on copper for 24 hours at any rate. Fundamentally, however, the world continues to suffer from an inadequate rate of consumption. The news in the closing days of February that U.K. wire mills had failed to conclude all the export business with Russia that had been hoped for was a bearish factor, although, after considerable discussion and speculation, some sales of Chilean copper wire to Russia are now reported to have been concluded.

There are certain technical aspects of the copper market which are quite interesting. Most important is undoubtedly the question of the possible re-imposition of the suspended U.S. import duty. It is probably quite well known by now that if the U.S. domestic price falls to or below 24 cents per lb. for a month or longer the Tariff Commission has authority to apply a duty of two cents per lb. as a matter of administration, as these are the provisions of the existing legislation. The term domestic price has been widely taken to mean the average of the domestic and export average prices published in the *Engineering and Mining Journal*, although this is not necessarily the only criterion. As the month closed, with the producers quoting 25 cents and custom smelters 23 cents, it can be seen that the imposition of the duty would come as no surprise.

On the subject of average prices it should be recorded that on the basis of information supplied by nine leading producers the *Metal Bulletin* is now calculating and publishing in each of its twice-weekly issues a daily weighted average price for electrolytic copper delivered in Europe. All prices are reduced to the common denominator of wirebars c.i.f. main European and U.K. ports. So far consumers have not exhibited much enthusiasm about the new price (which is still only a few weeks old), while Metal Exchange reaction is naturally enough hostile. It remains to be seen, however, whether the producers who sponsored the price will be able to urge its adoption as a pricing medium.

U.K. December copper consumption was 38,104 tons refined and 10,530 tons in scrap, making a monthly total of 48,634 tons and a grand total for 1957 of 641,484 tons, against 633,052 tons the year before. Production in the month was 8,578 tons primary and 7,742 tons secondary refined; grand total production for the year was 204,072 tons refined copper. Stocks ended the year at 70,781 tons.

Tin.—The tin market is moving into an interesting phase.[1] As has been noted in previous reports the export quotas now in force must ultimately alter the relationship between supply and demand of tin in the world, even in the face of such aggravating bear factors as the continued lack of consumer interest in the U.S.A. and the heavy shipments of tin which have been and are being made from Russia. Any signs that such a reversal in imbalance is imminent are eagerly awaited and account for the nervous tendency of prices. An illustration of the fascinating complexity of the metals world is provided by the influence of the Chinese New Year on the tin market. Malayan mines, obliged to pay up their outstanding debts at that time, according to custom, have been producing at a fairly heavy rate up to the end of the Old Year and, as a result, quite a few have now exhausted their quotas for the period ended March 30 and have additionally accumulated all the concentrates that are permitted. The heavy rate of production has, of course, resulted in a big output at the Malayan smelters, much of the resultant metal coming to the Buffer Stock in London. By the end of February, however, it had become possible to note a decline in the rate of such shipments.

February saw the registration of a Russian tin brand on the London Metal Exchange.

U.K. December consumption was 1,420 tons and for 1957 21,787 tons (22,232 tons in 1956). Production was 3,446 tons in December, giving yearly totals of 34,499 tons (26,836 tons); stocks ended the year at 15,815 tons against only 3,175 a year before.

Lead.—February has seen further output reductions at lead mines in various parts of the world. Among the more important may be included a reduction by one day in ten working days at the mines in the Broken Hill area of Australia. In Africa the Tsumeb Corporation effected output reductions to the extent of about 20%, while St. Joseph Lead cut output by a "once-only" 6,000 tons.

There has been no improvement in the uncertainty surrounding the application for higher U.S. lead-zinc tariffs. It now seems virtually certain that the last few days of March is the earliest time at which a Tariff Commission report can be expected. Even if consuming support were better than it is such uncertainty would still affect the tone of the market[1] adversely. Coming on top of news about consumption in the U.S.A. (which is already at a low level) and in Europe (where the tendency is less auspicious) the uncertainty is indeed a serious bear factor. There are also serious doubts about the rate of spending in the 1958 financial year of the various Government departments in the U.K.—such as, the Post Office—which are big lead consumers.

[1] Recent prices, pp. 136, 176.

[2] See Table, p. 176.

[1] See Table, p. 176.

U.K. December consumption was 26,530 tons, making the year 349,156 tons (1956 357,694 tons). Production was 6,563 tons, 85,721 tons, and 94,477 tons respectively. Stocks ended the year at 51,295 tons against 39,420 tons a year before.

Zinc.—The satisfactory conditions in the motor-car industry in the U.K. and in Germany has misled the economists who have seen this industry as a sensitive economic indicator. The activity [1] is however, something for which the zinc industry is profoundly grateful. Consumption of zinc in most other directions remains at a very low ebb both in the U.S.A. and in Europe it is difficult to find any outlet that is not running at a rather lower rate than it was, say, six months ago.

U.K. December consumption was 24,419 tons, making the year's total 316,406 tons (318,511 tons in 1956). Production figures are, respectively, 6,716 tons, 76,885 tons, and 81,470 tons. Stocks stood at 44,926 tons at the end of the year (44,816 tons a year earlier).

Iron and Steel.—Basically conditions in the British iron and steel industry are unchanged, with some sectors very actively engaged and others feeling the cool winds of recession. Total raw steel production this year is now thought unlikely to exceed 22,000,000 ingot tons, a level similar to 1957 output. The mills engaged in cold-reduced sheet production continue to be overwhelmed with orders, especially from the motor industry, and imports of sheets continue on a large scale. Imports of plates, too, are not inconsiderable, but conditions in heavy sections are a little easier. Strip is in brisk demand (this being a material also closely linked with motor industry activity), but the call for re-rolled bars and sections, hot rolled sheets (hand mill), galvanized sheets, and tinplate is much diminished. There has been a collapse of overseas galanized-sheet business and U.K. exports have fallen from 19,583 tons last August to only 5,320 tons in January this year.

It had been hoped that total exports of iron and steel could be boosted above the record of 3,160,000 tons in 1957, but the January figures give an indication how difficult this is going to be in view of the general world recession. Last month U.K. exports totalled 239,430 tons, against 240,529 tons a year earlier. Following reductions in galvanized-sheet export prices in January re-rolled steel has now been reduced and price cuts on plates and heavy sections become applicable on April 1. These cuts have not been particularly severe, however, and Continental and Japanese mills still have the advantage in many markets.

Iron Ore.—Stocks of iron ore at the furnaces are now around 3,000,000 tons, a figure which is considered satisfactory. Imports this year are expected to total 16,500,000 tons, against 16,000,000 tons in 1957.

Aluminium.—Reference was made in the December report to Russian infiltration into the U.K. aluminium market. This activity has led to an application being made under the Anti-Dumping Act for the imposition of an anti-dumping duty on metal entering the U.K. from Russia. Although the application is still technically under consideration—and, in fact, the outcome of the application is an event which is awaited with keen interest—the past few weeks have seen the emergence of an interesting industry reaction. At a recent meeting of the Aluminium Industry Council it was shown that those responsible for absorbing 80% of the U.K. aluminium consumption were not opposed to the duty being applied; of the remainder only 5% (on a tonnage basis) were definitely opposed. Other considerations may well enter into the final decision on whether or not it would be advantageous to apply the duty, but this indication of industry's attitude is of marked interest.

Canadian aluminium is still basically quoted at £197 per long ton delivered, with East European metal available well below.

Antimony.—A sharp decline in the U.S. antimony regulus price—from 33 cents to 29 cents—emphasized that conditions in the antimony market there are not a lot better than in Europe. Although price indications for Russian and Chinese regulus are still about the same and although the U.K. regulus prices are still £197 10s. for 99·6% and £190 for 99%, the weakness of the market has not gone unreflected. Antimony ore is now quoted a shilling a unit lower than the prices indicated in the January report, with the market exhibiting scant strength.

Arsenic.—Arsenic trading has been quiet and featureless in the past month. A change in the price of metal would, of course, be unexpected (remaining £400 per ton), but it would not be out of the question for a movement away from the level of £45 per ton which prevails for white arsenic. January imports of the latter were 450 tons.

Bismuth.—There have been no startling changes on either the pharmaceutical or the metallurgical sides of the bismuth market, but in conformity with general trade some slowing down in the rate of sales may be detected. Prices are maintained at 16s. per lb. for metal in ton lots.

Cobalt.—Speaking in New York during the past month the director of the Centre d'Information du Cobalt observed that world consumption was now only half production. This fact, he said, should allay any fears about the possible non-availability of cobalt for any of the many purposes to which it is put. U.K. cobalt prices are unchanged, metal being 16s. per lb.

Cadmium.—The price structure of cadmium never remains a source of excitement for long and it seems to be true that the market has now settled down on the basis of 10s. per lb. for primary forms of metal. At this level competition from "outside" sources is considerably reduced, although the prevailing price on the Continent indicates that competition is still possible. January imports were 85,031 lb.

Chromium.—There is considerable excitement in the ferro-chrome world about competition from Russian and East European material. So far, however, there has been no evidence of any such competition in chromium metal. The price of this is unchanged at 6s. 11d. to 7s. 4d. per lb.

Tantalum.—There are somewhat conflicting views about the state of the tantalite market. The price is still indicated at 900s. to 1,000s. per unit for 60% ore, but some factors contend that the demand is not so pressingly eager as formerly; others see no sign of this. The key to the situation appears to lie in the U.S.A.

Platinum.—The intimation in the last report that a general lowering in the platinum price level might be seen has been borne out. The leading two sellers in the U.K. are now quoting £26 15s. per oz. (against a range of £27 10s. to £28 10s. per oz. formerly), with a comparable price in the U.S.A. Others, however,

[1] See Table, p. 177.

maintain a lower level which is currently indicated in London in the region of £25 per oz.

Iridium.—The iridium market has not been characterized by any major developments in the past month and prices are quotably unchanged at £27 to £30 per oz.

Osmium.—Osmium, too, has been featureless in February and the price (which remains necessarily nominal) is £22 to £25 per oz.

Palladium.—At the present low level palladium is still not in as great demand as producers would like. Basically, however, the market situation may be related to the general condition of world trade. Palladium is still quotable at £7 10s. per oz.

Platinum metals imports into the U.K. in January were 20,896 oz.

Tellurium.—This featureless market remained without incident in February ; prices are still around 15s. to 16s. per lb.

Tungsten.—The impetus of the recovery in tungsten ore prices carried the quotation to 102s. 6d. a unit at one time, but it is interesting that the lower end of the range has stood at 95s. since January 31. Since then a mild recession from the top has brought the price back to 95s. to 100s. per unit c.i.f. and the future course of the market is obscure. Basically it is difficult to see how the market can move much either way, at any rate until the general tempo of world business speeds up a little, and a rather dreary tug of war between buyers and sellers is quite possible.

Nickel.—The nickel supply position continues to ease gently on a global basis, although the situation is not uniform. The degree of easing in the supply position has proceeded further in the U.S.A. than in the U.K., for example, although it would be incorrect to say that a shortage still existed anywhere. It is, for instance, quite some time now since scrap nickel was higher than virgin metal and there is a general reluctance to buy any material from non-Canadian sources at more than the established price of £600 per ton.

Chrome Ore.—Announcements in February about the closure of mines in Transvaal and Rhodesia emphasize the unsatisfactory state of the chrome-ore market. Consumers are affording the market very little support, apart from the fact that in the ferro-chrome field they themselves are experiencing a certain contraction of their markets due to East European sales activity ; as far as the ore is concerned Russian competition is not absent also. In Turkey an undertaking has been set up with Government participation to help finance the chrome-ore mines' more important problems in the way of capital expenditure. Chiefly this covers transportation and exploration. Contract prices for Rhodesian ore remain unchanged, metallurgical 48% ore being £17 5s. a ton c.i.f.

Molybdenum.—The world molybdenite supply position continues to ease and there is now a quite distinct surplus in the U.S.A. In the U.K. consumers still have the advantage of the heavy quantities of ore which they took up during the second half of last year ; similarly, there is no shortage on the Continent. Currently, however, the basic price remains 8s. 5d. per lb. Mo, f.o.b. Climax, Colo.

Manganese.—There has been no change in the soft trend of the manganese-ore market during February, although a study of quoted prices shows that the easiness is largely attributable to stagnation and consumer apathy ; compared with a quotation of 107d. to 115d. per long-ton unit of Mn last month, the market is now nominally indicated at 107d. to 113d. With the steel operating rate in the U.S.A. at an unhealthy level and showing poor resilience the outlook for manganese ore for the next few months is not brilliant. U.K. January imports were 46,121 tons.

Tin, Copper, Lead, and Zinc Markets

Tin, minimum, 99·75% ; Copper, electro ; Lead, minimum 99·75% ; and Zinc, minimum 98% per ton.

Date	Tin		Copper		Lead		Zinc	
	Settlement	3 Months	Spot	3 months	Spot	3 months	Spot	3 months
	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Feb. 11	731 0	726 15	160 12½	162 2⅓	73 11¼	73 11¼	64 2½	63 12½
12	730 10	727 5	160 12½	161 17½	73 13¾	73 16½	64 5	63 12½
13	730 10	729 15	160 5	161 12½	73 12½	73 12½	64 0	63 7½
14	730 10	731 0	160 17½	161 17½	74 1¼	73 17½	63 13¾	63 11¼
17	730 10	731 5	163 0	163 17½	74 7½	74 2½	64 2½	63 17½
18	732 0	732 10	162 12½	163 12½	74 15	74 7½	63 17½	63 10
19	737 0	738 10	163 12½	164 7½	76 2½	75 12½	64 11¼	63 18¾
20	734 0	735 10	162 17½	163 17½	75 7½	74 17½	64 1¼	63 16½
21	736 0	737 15	163 17½	165 2½	75 17½	75 7½	64 1¼	63 16½
24	738 0	739 10	163 10	164 12½	75 13¾	75 13¾	63 12½	63 12½
25	732 0	734 10	161 7½	163 2½	74 16¼	74 11¼	63 2½	62 17½
26	730 10	732 10	160 12½	161 17½	74 3¾	73 12½	61 17½	62 11½
27	731 10	735 15	160 12½	161 17½	73 12½	73 7½	61 7½	62 2½
28	730 10	734 5	160 7½	162 2½	73 2½	73 2½	61 7½	62 7½
Mar. 3	732 0	736 15	161 7½	163 2½	73 12¼	73 10	62 12½	62 11¼
4	732 0	736 10	163 10	165 7½	74 6¼	73 17½	63 5	63 10
5	732 0	738 10	162 12½	164 12½	74 16¼	74 18¾	63 11¼	63 7½
6	735 0	740 10	166 5	168 7½	75 16¼	75 2½	64 1¼	63 17½
7	738 0	742 10	165 2½	167 2½	74 12½	74 2½	63 2½	63 3½
10	731 0	739 10	163 2½	165 2½	74 7½	73 11¼	62 18¾	63 18¾

Statistics

TRANSVAAL AND O.F.S. GOLD OUTPUTS

	January		February	
	Treated Tons.	Yield Oz.†	Treated Tons.	Yield Oz.*
Blyvooruitzicht	101,000	56,380	99,000	57,603
Brakpan	125,000	18,147	110,000	15,366
Buffelsfontein‡	106,000	35,172	106,000	35,182
City Deep	148,000	28,048	137,000	26,112
Cons. Main Reef	137,000	21,905	124,000	20,344
Crown Mines	231,000	35,604	209,000	32,623
Daggafontein	217,000	46,000	209,000	44,205
Doornfontein‡	86,000	35,733	83,000	34,507
D'rb'n Roodeport Deep	185,000	33,136	165,000	29,866
East Champ D'Or‡	12,000	285	11,500	304
East Daggafontein	90,000	15,000	84,500	14,006
East Geduld	127,000	39,053	115,000	35,364
East Rand P.M.	225,000	57,021	202,000	52,572
Eastern Transvaal Consol	18,000	6,064	17,700	5,943
Ellaton‡	32,000	7,294	30,000	6,831
Freddies Consol.	45,000	15,684	47,000	15,510
Free State Geduld	63,500	46,308	62,000	45,266
Geduld	86,000	13,620	77,000	12,144
Government G.M. Areas‡	65,000	11,392	60,000	10,727
Grootvlei Proprietary	195,000	41,544	180,000	38,426
Harmony Gold Mining	76,000	31,161	73,000	29,959
Hartebeestfontein‡	84,000	46,200	80,000	44,000
Libanon	103,000	23,093	99,000	22,744
Loraine	63,000	12,030	62,000	11,254
Luipaards Vlei‡	120,000	14,176	111,000	13,025
Marievale Consolidated	73,000	19,166	66,000	17,392
Merriespruit‡	—	—	—	—
Modderfontein East	138,000	13,936	121,000	12,327
New Kleinfontein	94,000	11,540	86,000	10,645
New Klerksdorp‡	9,400	868	11,200	1,045
President Brand	72,500	54,208	75,000	55,323
President Steyn	93,000	35,594	90,000	34,587
Rand Leases	160,000	24,280	150,000	22,725
Randfontein‡	179,000	15,755	162,000	13,984
Rietfontein Consolid't'd.	23,000	5,354	21,500	5,004
Robinson Deep	73,000	15,640	70,000	14,900
Rose Deep	56,000	7,760	53,000	7,445
St. Helena Gold Mines	118,000	34,693	108,000	32,244
Simmer and Jack	92,000	17,346	77,000	15,932
S. African Land and Ex.	86,000	17,750	81,000	16,874
S. Roodepoort M.R.	31,000	7,234	27,000	6,460
Spaarwater Gold	10,300	3,289	10,330	3,219
Springs	126,000	14,180	119,000	13,189
Stilfontein Gold Mining‡	108,000	53,622	107,000	53,125
Sub Nigel	66,500	16,609	64,000	15,546
Transvaal G.M. Estates	18,700	2,774	16,400	2,585
Vaal Reefs‡	67,500	30,365	63,000	28,352
Van Dyk Consolidated	77,000	13,592	71,000	12,580
Venterspost Gold	115,000	28,406	113,000	27,855
Village Main Reef	32,000	5,307	27,000	4,581
Virginia O.F.S.‡	98,000	25,970	98,000	25,480
Vlakfontein	48,000	17,067	48,000	16,951
Vogelstruisbult‡	96,000	21,914	96,000	21,811
Welkom Gold Mining	80,000	23,965	81,000	24,104
West Driefontein‡	75,000	72,370	75,000	72,132
West Rand Consol. ‡	183,000	16,500	190,000	19,751
Western Holdings	94,000	49,650	91,000	48,940
Western Reefs	104,000	25,344	106,000	24,649
Witwatersrand Nigel	17,800	4,304	17,200	4,255

† 248s. 4d. * 248s. 9d. ‡ Gold and Uranium.

COST AND PROFIT IN THE UNION

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Dec. 1956	16,444,200	59 8	44 5	15 3	19,449,432
Jan., 1957	—	—	—	—	—
Feb.	—	—	—	—	—
Mar.	16,430,800	60 8	44 8	16 0	20,657,462
April	—	—	—	—	—
May	—	—	—	—	—
June*	16,785,200	62 4	45 1	17 3	22,595,371
July	—	—	—	—	—
August	—	—	—	—	—
Sept.*	16,699,900	64 0	45 6	17 3	24,193,575
Oct.	—	—	—	—	—
Nov.	—	—	—	—	—
Dec.	—	—	—	—	—

* 3 Months.

PRODUCTION OF GOLD IN SOUTH AFRICA

	Rand and O.F.S.	Outside	Total
	Oz.	Oz.	Oz.
March, 1957	1,288,140	38,765	1,405,422
April	1,366,657	36,979	1,398,667
May	1,361,688	45,361	1,450,668
June	1,405,307	24,957	1,420,021
July	1,395,064	53,099	1,479,439
August	1,426,340	38,941	1,459,794
September	1,400,745	37,611	1,438,356
October	1,416,211	39,996	1,456,207
November	1,386,047	36,470	1,422,517
December	1,366,354	35,789	1,402,143
January, 1958	1,377,505	40,534	1,418,039
February	1,322,843	33,879	1,356,722

NATIVES EMPLOYED IN THE SOUTH AFRICAN MINES

	Gold Mines	Coal Mines	Total
June 30, 1957	335,756	29,411	371,105
July 31	329,142	29,083	365,167
August 31	322,847	28,604	351,451
September 30	315,955	28,170	344,125
October 31	310,428	28,020	338,448
November 30	305,104	27,619	332,723
December 31	299,137	27,623	326,760
January 31, 1958	314,239	28,489	342,728
February 28	326,885	30,227	357,112

MISCELLANEOUS METAL OUTPUTS

	4-Week Period To Jan. 31		
	Tons Ore	Lead Concs. tons	Zinc Concs. tons
Broken Hill South	15,330	2,279	2,953
Electrolytic Zinc	14,035	714	3,839
Lake George	22,139	1,731	3,317
Mount Isa Mines**	59,953	1,855†	2,828
New Broken Hill	52,297	7,729	10,587
North Broken Hill	16,735	2,795	2,957
Zinc Corp.	44,233	6,999	7,652
Rhodesia Broken Hill*	—	—	—

* 3 Mths. ** Copper 2,180 tons. † Metal.

RHODESIAN GOLD OUTPUTS

	January		February	
	Tons	Oz.	Tons	Oz.
Cam and Motor	32,640	10,031	30,584	9,748
Falcon Mines	19,425	3,804	20,000	3,850
Globe and Phœnix	6,000	3,605	—	—
Motapa Gold Mining	14,000	1,730	—	—
Mazoe	3,141	930	2,790	903
Coronation Syndicate	11,409	4,409	10,658	4,217

WEST AFRICAN GOLD OUTPUTS

	January		February	
	Tons	Oz.	Tons	Oz.
Amalgamated Banket	60,153	14,986	60,969	15,205
Ariston Gold Mines	41,160	12,636	40,730	11,930
Ashanti Goldfields	30,000	22,500	30,000	25,000
Bibiani	33,500	6,900	35,000	6,900
Bremang	—	4,756	—	4,407
Ghana Main Reef	11,724	4,117	11,816	4,203
Konongo	5,520	3,855	5,550	3,980
Lyndhurst	—	—	—	—
Marlu	—	—	—	—
Nanwa	—	—	—	—
Taquah and Abosso	—	—	—	—

PRODUCTION OF GOLD AND SILVER IN RHODESIA

	1956		1957	
	Gold (oz.)	Silver (oz.)	Gold (oz.)	Silver (oz.)
January	44,619	5,841	44,337	6,134
February	41,858	5,347	41,607	5,697
March	43,799	5,543	43,831	8,179
April	46,577	6,346	46,754	6,854
May	45,822	7,891	42,650	5,606
June	45,996	6,838	46,682	6,441
July	46,178	7,084	41,922	5,781
August	46,427	6,531	44,001	5,897
September	44,654	6,400	45,762	5,677
October	44,486	6,473	46,838	5,570
November	42,648	6,599	46,987	6,331
December	43,327	6,008	—	—

WESTRALIAN GOLD PRODUCTION

	1955	1956	1957
	Oz.	Oz.	Oz.
January	65,711	66,388	106,722
February	63,441	94,638	64,949
March	111,675	66,944	67,121
April	62,211	60,415	66,435
May	61,672	62,294	64,886
June	64,201	63,570	65,142
July	63,441	69,883	74,420
August	70,221	72,303	75,727
September	75,055	62,204	64,422
October	71,102	64,594	64,524
November	66,622	64,113	65,700
December	66,679	65,031	66,562
Total	842,004	812,377	846,610

AUSTRALIAN GOLD OUTPUTS

	4-Week Period			
	To Jan. 21		To Feb. 18	
	Tons	Oz.	Tons	Oz.
Boulder Perseverance	—	—	—	—
Central Norseman	14,022	8,215	13,682	8,198
Crœsus Proprietary	—	—	—	—
Gold Mines of Kalgoorlie	39,978	11,357	40,354	11,997
Golden Horse Shoe*	—	—	—	—
Gt. Boulder Prop.*	—	—	—	—
Gt. Western Consolidated	39,706	5,930	42,844	6,212
Kalgoorlie Enterprise	—	—	—	—
Kalgurli Ore Treatment	—	—	—	—
Lake View and Star*	—	—	—	—
Moonlight Wiluna*	—	—	—	—
Morning Star (G.M.A.)	1,535	574	—	—
Mount Ida	—	—	—	—
New Coolgardie	—	—	—	—
North Kalgurli	26,551	5,929	26,556	5,269
Sons of Gwalia	8,798	1,584	—	—
South Kalgurli	—	—	—	—
Mount Morgan	—	3,634	—	3,542

* 3 Months.

ONTARIO GOLD AND SILVER OUTPUT

	Tons Milled	Gold Oz.	Silver Oz.	Value Canad'n $
September, 1956	701,236	192,979	26,355	6,627,079
October	754,191	212,490	34,854	7,159,732
November	747,059	209,797	34,135	7,102,110
December	741,525	213,846	60,129	7,180,865
Jan., 1957	759,681	210,404	33,082	7,114,391
February	702,636	197,225	32,199	6,635,527
March	793,674	215,830	35,787	7,250,018
April	771,608	216,457	35,685	7,314,450
May	790,159	222,436	37,241	7,509,638
June	738,384	207,897	32,544	6,945,127
July	718,468	198,620	30,620	6,572,323
August	701.174	192,453	31,647	6,410,429
September	722.384	205.471	34.248	6.947.813
October	772,383	224,217	37,086	7.657.426
November	756.494	219.352	37.737	7.441.702
December	750,537	215,462	44,230	7,494,289

MISCELLANEOUS GOLD AND SILVER OUTPUTS

	Jan.		Feb.	
	Tons	Oz.	Tons	Oz.
British Guiana Cons.	—	1,712	—	—
Central Victoria Dredging	—	—	—	—
Clutha River	—	582	—	464
Emperor Mines (Fiji)*	—	—	45,207	15,430
Frontino Gold (Colombia)	—	—	—	—
Geita Gold (Tanganyika)	25,000	3,929	—	—
Harrietville (Aust.)	—	—	—	—
Lampa (Peru)†	—	36,064	—	—
Loloma (Fiji)*	—	—	—	—
New Guinea Goldfields	—	—	—	—
St. John d'el Rey (Brazil)	24,200	£125,000	—	—
Yukon Consol.	—	—	—	—

* 3 Months. † Ozs. Silver: 64½ tons copper; 66½ tons.

OUTPUTS OF MALAYAN TIN COMPANIES IN LONG TONS OF CONCENTRATES

	Dec.	Jan.	Feb.
Ampat Tin	90	69½	60
Austral Amalgamated	220	—	—
Ayer Hitam	112½*	—	—
Batu Selangor	—	—	—
Berjuntai	117	121	79
Chenderiang	47*	—	—
Gopeng Consolidated	243*	—	—
Hongkong Tin	128*	—	—
Idris Hydraulic	44½*	—	—
Ipoh	22	—	—
Jelapang Tin	—	—	—
Kampong Lanjut	91½	98	70
Kamunting	117½	38½	59½
Kent (F.M.S.)	55*	—	—
Kepong	155*	—	—
Killinghall	170½*	—	—
Kinta Kellas	36	—	—
Kinta Tin Mines	57	—	—
Klang River	—	—	—
Kramat	47	47½	41
Kuala Kampar	150	87	74
Kuala Lumpur	—	—	—
Kuchai	—	—	—
Lahat Mines	—	—	—
Larut	24½	28	29
Lower Perak	165	124½	137
Malayan	619*	—	—
Malaysiam	23½	9	5½
Pacific Tin Consolidated	—	—	—
Pahang Consolidated	184	135	—
Pengkalen	116*	—	—
Petaling Tin	217*	—	—
Puket	182*	—	—
Rahman Hydraulic	—	—	—
Rambutan	58	—	—
Rantau	59	54½	43½
Rawang Concessions	—	—	—
Rawang Tin Fields	—	—	—
Renong	76	—	—
Selayang	51*	—	—
Siamese Tin Syndicate (Malaya)	36	—	10½
Southern Kinta	335	248	305
Southern Malayan	113*	—	—
Southern Tronoh	102*	—	—
Sungei Besi	369*	—	—
Sungei Kinta	20½	—	—
Sungei Way	423*	—	—
Taiping Consolidated	58½	54	39
Tambah	—	—	—
Tanjong	59	—	—
Tekka	49	—	—
Tekka-Taiping	34	30	—
Temoh	14*	—	—
Tongkah Compound	—	—	—
Tongkah Harbour	61½	26½	26½
Tronoh	677*	—	—
Ulu Klang	—	—	—

* 3 Months.

MISCELLANEOUS TIN COMPANIES' OUTPUTS IN LONG TONS OF CONCENTRATES

	Jan.		Feb.	
	Tin	Columbite	Tin	Columbite
Amalgamated Tin Mines	289	32	393	39
Anglo-Burma Tin	21	—	20	—
Bangrin	—	—	42	—
Beralt	38	130†	40	120†
Bisichi	83½	19	78½	10
Ex-Lands Nigeria	37	—	37	—
Geevor	63	—	—	—
Gold and Base Metal	47	—	43	—
Jantar Nigeria	21½	12	28	20
Jos Tin	14	—	—	—
Kaduna Prospectors	5½	—	6½	—
Kaduna Syndicate	19	—	25	—
Katu Tin	—	—	21	—
Keffi Tin	22	7	—	—
London Nigerian Mines	25	—	—	—
Naraguta Extended	13	—	—	—
Naraguta Karama	13	—	—	—
Naraguta Tin	—	—	—	—
Renong Consolidated	—	—	17	—
Ribon Valley (Nigeria)	14	—	—	—
Siamese Tin Syndicate	—	—	62	—
South Bukeru	—	—	—	—
South Crofty	57	—	56	—
Tavoy Tin	15	—	—	—
Thabawleik	—	—	—	—
Tin Fields of Nigeria	2	—	—	—
United Tin Areas of Nigeria	2	—	—	—

† Wolfram.

SOUTH AFRICAN MINERAL OUTPUT
December, 1957

Gold	1,401,238 oz.
Silver	148,719 oz.
Diamonds	204,113 carats.*
Coal	3,186,993 tons.
Copper	(*a*) 163 tons in matte and copper-gold concentrates. (*b*) 4,704 tons of 99·32%.
Tin	362 tons concs.
Platinum (concentrates, etc.)	—
Platinum (crude)	—
Asbestos	14,881 tons.
Chrome Ore	66,886 tons.
Manganese Ore	109,368 tons.
Lead Concs.	94 tons.

*Nov., 1957.

IMPORTS OF ORES, METALS, ETC., INTO UNITED KINGDOM

		Dec.	Jan.
Iron Ore	tons	1,142,988	1,276,115
Manganese Ore	,,	37,057	46,121
Iron and Steel	,,	82,756	96,598
Iron Pyrites	,,	35,384	15,755
Copper Metal	,,	44,617	32,878
Tin Ore	,,	5,821	9,145
Tin Metal	,,	3,125	2,335
Lead	,,	15,600	15,858
Zinc Ore and Conc.	,,	28,866	26,743
Zinc	,,	11,983	10,136
Tungsten Ores	,,	504	313
Chrome Ore	,,	12,750	15,783
Bauxite	,,	35,424	46,300
Antimony Ore and Concs.	,,	387	379
Titanium Ore	,,	22,251	36,996
Nickel Ore	,,	2,771	2,896
Tantalite/Columbite	,,	20	18
Sulphur	,,	18,746	28,758
Barytes	,,	3,444	4,894
Asbestos	,,	9,548	6,883
Magnesite	,,	3,420	3,545
Mica	,,	589	200
Graphite	,,	384	306
Mineral Phosphates	,,	81,237	83,609
Molybdenum Ore	,,	763	474
Nickel	cwt.	20,528	32,847
Aluminium	,,	429,931	292,317
Mercury	lb.	57,001	53,841
Bismuth	,,	89,999	96,673
Cadmium	,,	130,988	85,031
Cobalt and Cobalt Alloys	,,	14,138	81,025
Selenium	,,	16,552	2,897
Petroleum Motor Spirit	1,000 gals.	56,024	55,914
,, Crude	,,	617,713	672,892

Prices of Chemicals

The figures given below represent the latest available.

		£	s.	d.
Acetic Acid, Glacial	per ton	106	0	0
,, ,, 80% Technical	,,	97	0	0
Alum, Comml.	,,	25	0	0
Aluminium Sulphate	,,	16	10	0
Ammonia, Anhydrous	per lb.		2	0
Ammonium Carbonate	per ton	59	0	0
,, Chloride, 98%	,,	26	0	0
,, Phosphate (Mono- and Di-)	,,	102	0	0
Antimony Sulphide, golden	per lb.		3	0
Arsenic, White, 99/100%	per ton	47	10	0
Barium Carbonate (native), 94%	,,	Nominal		
,, Chloride	,,	53	0	0
Barytes (Bleached)	,,	20	0	0
Benzole	per gal.		5	2
Bleaching Powder, 36% Cl.	per ton	30	7	6
Borax	,,	44	0	0
Boric Acid, Comml.	,,	73	10	0
Calcium Carbide	,,	40	17	9
,, Chloride, solid, 70/75%	,,	12	10	0
Carbolic Acid, crude 60's	per gal.		8	3
Carbon Bisulphide	per ton	62	10	0
Chromic Acid (ton lots)	per lb.		2	2½
Citric Acid	per cwt.	10	15	0
Copper Sulphate	per ton	67	0	0
Creosote Oil (f.o.r. in Bulk)	per gal.		1	1
Cresylic Acid, 97–98%	,,		6	6
Hydrochloric Acid 28° Tw.	per carboy		13	0
Hydrofluoric Acid, 59/60%	per lb.		1	1
Iron Sulphate	per ton	3	17	6
Lead, Acetate, white	,,	124	0	0
,, Nitrate	,,	116	0	0
,, Oxide, Litharge	,,	110	10	0
,, Red	,,	106	15	0
,, White	,,	104	15	0
Lime, Acetate, brown	,,	40	0	0
Magnesite, Calcined	,,	20	0	0
,, Raw	,,	9	0	0
Magnesium Chloride, ex W'h'se	,,	16	0	0
,, Sulphate, Comml.	,,	15	10	0
Methylated Spirit, Industrial, 66 O.P.	per gal.		6	3
Nitric Acid, 80° Tw.	per ton	37	10	0
Oxalic Acid	,,	129	0	0
Phosphoric Acid (S.G. 1·750)	per lb.		1	4
Pine Oil	per ton	Nominal		
Potassium Bichromate	per lb.		1	2½
,, Carbonate (hydrated)	per ton	74	10	0
,, Chloride, 96%	,,	21	0	0
,, Iodide	per lb.		9	0
,, Amyl Xanthate	,,	Nominal		
,, Ethyl Xanthate	,,	Nominal		
,, Hydrate (Caustic) solid	per ton	118	0	0
,, Nitrate	per cwt.	4	1	0
,, Permanganate	per ton	193	10	0
,, Sulphate, 48%	,,	22	6	0
Sodium Acetate	,,	99	0	0
,, Arsenate, 58–60%	,,	Nominal		
,, Bicarbonate	,,	15	0	0
,, Bichromate	per lb.		1	0
,, Carbonate (crystals)	per ton	Nominal		
,, ,, (Soda Ash) 58%	,,	13	10	0
,, Chlorate	,,	90	0	0
,, Cyanide 100% NcAN basis	per cwt.	6	6	6
,, Hydrate, 76/77%, solid	per ton	33	0	0
,, Hyposulphite, Comml.	,,	32	15	0
,, Nitrate, Comml.	,,	29	10	0
,, Phosphate (Dibasic)	,,	40	10	0
,, Prussiate	per lb.		1	0½
,, Silicate	per ton	11	0	0
,, Sulphate (Glauber's Salt)	,,	9	15	0
,, ,, (Salt-Cake)	,,	8	0	0
,, Sulphide, flakes, 60/62%	,,	37	2	6
,, Sulphite, Comml.	,,	27	10	0
Sulphur, American, Rock (Truckload)	,,	17	0	0
,, Ground, Crude	,,	19	0	0
Sulphuric Acid, 168° Tw.	,,	10	15	0
,, ,, free from Arsenic, 140° Tw.	,,	8	3	0
Superphosphate of Lime, 18% P_2O_5	,,	14	16	0
Tin Oxide	,,	Nominal		
Titanium Oxide, Rutile	,,	177	0	0
,, White, 25%	,,	83	10	0
Zinc Chloride	,,	Nominal		
,, Dust, 95/97% (4-ton lots)	,,	104	0	0
,, Oxide	,,	88	0	0
,, Sulphate	,,	32	0	0

Share Quotations

Shares of £1 par value except where otherwise stated.

GOLD AND SILVER:	Feb. 10, 1958 £ s. d.	Mar. 10, 1958 £ s. d.
SOUTH AFRICA:		
Blinkpoort (5s.)	1 16 9	2 0 0
Blyvooruitzicht (2s. 6d.)	19 3	1 0 6
Brakpan (5s.)	4 0	5 0
Buffelsfontein (10s.)	1 15 6	1 17 9
City Deep	11 3	13 6
Consolidated Main Reef	10 9	12 3
Crown Mines (10s.)	1 0 0	1 1 6
Daggafontein (5s.)	1 5 3	1 8 3
Dominion Reefs (Ord. 5s.)	12 6	12 6
Doornfontein (10s.)	1 1 3	1 3 6
Durban Roodepoort Deep (10s.)	1 4 9	1 8 3
East Champ d'Or (2s. 6d.)	2 3	2 3
East Daggafontein (10s.)	7 3	8 9
East Geduld (4s.)	1 0 6	1 3 0
East Rand Proprietary (10s.)	1 16 9	2 1 3
Freddies Consol	3 0	3 0
Free State Dev. (5s.)	4 0	4 6
Free State Geduld (5s.)	3 17 6	4 1 0
Free State Saaiplaas (10s.)	12 3	13 0
Geduld	2 14 3	3 1 3
Government Gold Mining Areas (5s.)	3 3	3 6
Grootvlei (5s.)	13 3	15 0
Harmony (5s.)	1 10 0	1 12 9
Hartebeestfontein (10s.)	2 16 6	2 17 6
Libanon (10s.)	6 3	7 6
Loraine (10s.)	2 0	2 6
Luipaards Vlei (2s.)	10 0	11 0
Marievale (10s.)	16 6	18 3
Merriespruit (5s.)	4 0	4 0
Modderfontein B (3d.)	2 3	2 0
Modderfontein East	10 9	12 0
New Kleinfontein	3 3	3 9
New Pioneer (5s.)	1 5 6	1 8 3
New State Areas (16s.)	1 3	1 3
President Brand (5s.)	2 7 6	2 9 3
President Steyn (5s.)	1 7 3	1 8 9
Rand Leases (10s.)	3 6	4 3
Randfontein	1 5 6	1 7 0
Riebeeck (10s.)	11 6	11 3
Rietfontein (5s.)	7 9	8 0
Robinson Deep (7s. 6d.)	6 3	7 3
Rose Deep (9s. 6d.)	9 6	10 6
St. Helena (10s.)	1 16 9	1 18 6
Simmer and Jack (2s. 6d.)	3 9	4 0
South African Land (3s. 6d.)	18 6	1 1 6
Springs (5s.)	1 6	2 0
Stilfontein (5s.)	1 15 3	1 17 9
Sub Nigel (10s.)	11 3	12 0
Vaal Reefs (5s.)	1 16 6	1 17 6
Van Dyk (9s.)	3 3	3 6
Venterspost (10s.)	12 6	14 3
Virginia (5s.)	7 6	7 9
Vlakfontein (10s.)	14 3	15 6
Vogelstruisbult (10s.)	9 0	9 9
Welkom (5s.)	13 6	14 3
West Driefontein (10s.)	4 11 3	4 11 3
West Rand Consolidated (10s.)	1 1 6	1 4 9
West Witwatersrand Areas (2s. 6d.)	1 18 0	1 19 9
Western Holdings (5s.)	4 6 9	4 11 3
Western Reefs (5s.)	1 5 3	1 6 6
Winkelhaak (10s.)	15 6	16 9
Witwatersrand Nigel (2s. 6d.)	1 3	1 3
RHODESIA:		
Cam and Motor (2s. 6d.)	8 0	8 3
Chicago-Gaika (10s.)	13 9	13 9
Coronation (2s. 6d.)	3 6	3 9
Falcon (5s.)	7 0	7 0
Globe and Phœnix (5s.)	1 6 0	1 4 9
Motapa (5s.)	6	6
GOLD COAST:		
Amalgamated Banket (3s.)	1 0	1 3
Ariston Gold (2s. 6d.)	4 0	4 6
Ashanti Goldfields (4s.)	14 3	13 0
Bibiani (4s.)	2 3	2 3
Bremang Gold Dredging (5s)	1 5	1 9
Ghana Main Reef (5s.)	1 3	1 9
Konongo (2s.)	1 6	2 0
Kwahu (2s.)	2 0	2 6
Taquah and Abosso (3s.)	6	6
Western Selection (5s.)	4 3	4 9
AUSTRALASIA:		
Gold Fields Aust. Dev. (3s.), W.A.	2 0	2 0
Gold Mines of Kalgoorlie (10s.)	9 3	9 3
Great Boulder Propriet'y (2s.), W.A.	12 0	12 3
Lake View and Star (4s.), W.A.	1 0 6	1 0 6
London-Australian (2s.)	7	9
Mount Morgan (10s.), Q.	7 0	6 9
New Guinea Gold (4s. 3d.)	1 3	1 3
North Kalgurli (1912) (2s.), W.A.	7 0	7 3
Sons of Gwalia (10s.), W.A.	2 6	2 0
Western Mining (5s.), W.A.	8 3	8 0

	Feb. 10, 1958 £ s. d.	Mar. 10, 1958 £ s. d.
MISCELLANEOUS:		
Fresnillo ($1·00)	2 10 0	2 4 6
Kentan Gold Areas (1s.), E. Africa	4	3
St. John d'el Rey, Brazil	2 11 3	2 14 3
Yukon Consolidated ($1)	4 3	4 9
COPPER:		
Bancroft Mines (5s.), N. Rhodesia	11 3	15 0
Esperanza (2s. 6d.), Cyprus	1 3	1 2
Indian (2s.)	3 0	3 0
Magundi (5s.)	2 3	3 3
Messina (5s.), Transvaal	3 6 3	3 8 3
Mount Lyell, Tasmania	16 6	16 9
Nchanga Consolidated, N. Rhodesia	8 8 0	8 17 0
Rhokana Corporation, N. Rhodesia	21 0 0	22 10 0
Roan Antelope (5s.), N. Rhodesia	7 0	7 6
Tanganyika Concessions (10s.)	4 11 3	5 0 0
LEAD-ZINC:		
Broken Hill South (5s.), N.S.W.	3 2 6	2 16 3
Burma Mines (3s. 6d.)	2 0	1 9
Consol. Zinc Corp. Ord.	2 6 9	2 7 6
Electrolytic Zinc, Tasmania (Pref. 5s.)	2 12 6	2 12 6
Lake George (5s.), N.S.W.	2 9	3 6
Mount Isa, Queensland (5s. Aust.)	1 2 3	1 1 6
New Broken Hill (5s.), N.S.W.	1 12 6	1 12 6
North Broken Hill (5s.), N.S.W	3 17 6	3 17 6
Rhodesia Broken Hill (5s)	6 6	7 0
San Francisco (10s.), Mexico	19 6	14 3
TIN:		
Amalgamated Tin (5s.), Nigeria	5 6	5 6
Ampat (4s.), Malaya	7 0	7 0
Ayer Hitam (5s.), Malaya	1 1 0	1 1 6
Beralt (5s.), Portugal	1 9 3	1 6 9
Bisichi (2s. 6d.), Nigeria	3 3	3 3
Ex-Lands (2s.), Nigeria	1 9	1 9
Geevor (5s.), Cornwall	15 0	15 3
Gold Base Metals (2s. 6d.), Nigeria	9	1 0
Hongkong (5s.), Malaya	5 9	4 9
Jantar Nigeria (3s.)	2 0	2 0
Kaduna Syndicate (2s.), Nigeria	2 3	2 3
Kamunting (5s.), Malaya	8 3	8 6
Kramat Pulai (3d.), Malaya	3 6	3 0
Malayan Tin Dredging (5s.)	9 9	10 6
Mawchi Mines (4s.), Burma	2 0	2 6
Naraguta Extended (5s.), Nigeria	9	1 2
Pahang (5s.), Malaya	4 6	4 9
Siamese Synd. (5s.)	8 3	7 6
South Crofty (5s.), Cornwall	5 9	5 9
Southern Kinta (5s.), Malaya	16 3	16 3
Southern Malayan (5s.)	9 0	9 3
Southern Tronoh (5s.), Malaya	8 3	8 0
Sungei Besi (4s.), Malaya	11 6	12 0
Sungei Kinta, Malaya	16 0	15 6
Tronoh (5s.), Malaya	9 3	9 0
United Tin Areas (2s. 6d.), Nigeria	4½	4½
DIAMONDS:		
Anglo American Investment	7 6 3	7 13 0
Consol African Selection Trust (5s.)	11 9	11 9
Consolidated of S.W.A. Pref (10s.)	10 9	10 9
De Beers Deferred (5s.)	4 9 0	4 17 9
FINANCE, Etc.		
African & European (10s.)	2 13 9	2 17 6
Anglo American Corporation (10s.)	5 5 0	6 2 3
Anglo-French Exploration	1 1 6	1 2 0
Anglo Transvaal 'A' (5s.)	1 9 3	1 10 0
British South Africa (15s.)	2 8 9	2 11 3
British Tin Investment (10s.)	15 6	15 3
Broken Hill Proprietary	1 14 3	1 14 6
Camp Bird (10s.)	—	—
Central Mining	2 14 6	2 17 6
Central Provinces Manganese (10s.)	1 3 0	1 3 6
Consolidated Gold Fields	2 7 9	2 8 9
Consolidated Mines Selection (10s.)	1 12 0	1 14 0
East Rand Consolidated (5s.)	1 3	1 6
Free State Development (5s.)	4 0	4 6
General Exploration O.F.S. (2s. 6d.)	3 0	3 0
General Mining and Finance	3 13 0	4 1 3
H.E. Proprietary (5s.)	7 9	7 6
Johannesburg Consolidated	2 3 9	2 5 0
London & Rhod. M. & L. (5s.)	7 0	7 9
London Tin Corporation (4s.)	7 3	7 3
Lydenburg Est. (5s.)	10 9	11 9
Marsman Investments (10s.)	2 6	2 6
National Mining	9	1 0
Rand Mines (5s.)	3 5 9	3 10 0
Rand Selection (5s.)	1 11 6	1 15 0
Rhodesian Anglo American (10s.)	2 12 6	2 16 3
Rhodesian Corporation (5s.)	4 0	4 0
Rhodesian Selection Trust (5s.)	13 9	14 6
Rio Tinto (10s.)	2 9 0	2 12 0
Selection Trust (10s.)	3 2 0	3 0 9
South West Africa Co. (3s. 4d.)	16 3	16 3
Union Corporation (2s. 6d.)	1 16 9	1 18 9
West Rand Inv. Trust (10s.)	2 0 9	2 5 9
Zambesia Exploring	2 1 0	2 0 6

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section abstracts of important articles and papers appearing in technical journals and proceedings of societies are given, together with brief records of other articles and papers; also notices of new books and pamphlets and lists of patents on mining and metallurgical subjects.

Studies on the Stability of Underground Openings

Since the discovery in 1939 that rock under stress generates sub-audible and sometimes audible disturbances which can be detected by suitable apparatus the United States Bureau of Mines has conducted a long series of investigations into the subject. In *Bulletin* 573 of the Bureau L. Obert and W. I. Duvall review this "Micro-Seismic Method of Determining the Stability of Underground Opening," summarizing the work carried out between 1940 and 1955 and briefly reviewing the characteristics of the so-called "micro-seismims" and the equipment used to record them.

In the usual test procedure, the authors say, the detection of areas of stress involves no more than placing a geophone in the suspected area and listening to or recording the micro-seismic activity. If no micro-seismims are detected the area can be considered stable; if micro-seismims are detected the geophone is in or near a stress area. The procedure assumes that the rock under test, if stressed, will generate micro-seismims; no exceptions have been found in the coring class of rock. Although the test is simple, it is stated, its importance should not be overlooked; in most of the investigations the problem has been to determine whether or not a suspected area—such as, a mine pillar, brow, or roof arch—was stable.

If micro-seismims are detected the next problem, it is suggested, is to find the centre and extent of the affected area, a procedure which can be effected by a number of means. Because the micro-seismic rate decreases with the distance from the point of origin the operator can probe from point to point with a single geophone until the area producing the maximum micro-seismic rate and hence the centre of the disturbance is located. Although the recording type of equipment is generally used for this test comparatively small areas of instability—such as would be encountered in roof-trimming operations—can be localized by aural testing.

Micro-seismic rates also can be used to localize a stress area by placing a number of geophones in the area at fixed positions and comparing the recorded micro-seismic rates from each. The geophone nearest the centre of disturbance will pick up the highest micro-seismic rate; the geophone next closest to the area, the next highest rate, etc. Because the amplitude of a micro-seismim decreases with the distance from the source comparison of the *average* amplitudes, as received from a number of points, can be used as a basis for localizing the point of origin. This can be accomplished either by probing with one geophone or employing a number of geophones at fixed points. In either instance the amplitude comparison should be made from a recording. Similarly the affected area may be localized by comparing the amplitude of a single micro-seismim at various points, rather than taking the average amplitudes of a group. The simultaneous reception and recording of a single micro-seismim from two or more geophones (referred to as a coincidence) requires the use of multichannel recording. Comparison of individual amplitudes is possible with the recording type of micro-seismic equipment previously described because the recording tapes are driven synchronously.

Finally the area can be localized by comparing the fraction of coincident and non-coincident recordings as received from each of a number of geophones. For example, the authors say, suppose that one geophone is planted close to the centre of the disturbance and a second geophone at some distance therefrom. Geophone 1 will pick up all the micro-seismims picked up by geophone 2 (coincidences) *plus* an additional number of insufficient intensity to travel the additional distance (non-coincidences). Where a number of geophones are used the one closest to the source will pick up the greater number of non-coincidences.

In general, probing methods are employed whenever the area under investigation is easily accessible, whereas comparison of micro-seismic rates or amplitudes from a group of geophones is employed to obtain data on inaccessible areas—areas where it might be difficult to drill holes for the placement of geophones. The micro-seismic method of detecting and localizing areas of stress is a relatively quantative procedure. No particular experience on the part of the operator either with respect to placement of geophones or interpretation of the data is required.

Estimating Magnitude of Stress and Predicting Failure

Estimating the magnitude of stress and determining if and when failure will occur are qualitative procedures that depend on the operator's familiarity with the load *vs.* micro-seismic rate relationship for the various rock types and on an analysis of structural problems, the normal stress pattern for various-shaped mine openings. Some indication of the load *vs.* micro-seismic rate relationship can be obtained by loading rock specimens in a hydraulic press and noting the corresponding micro-seismic rate. Additional information can be obtained by inducing small-scale failures in mines—such as roof falls—and noting the micro-seismic rate before and during the process. One informative test that usually can be effected in an operating mine is to plant geophones near a heading or bench round and to note the increase in the maximum micro-seismic production after the blast. This micro-seismic production results from the working of the rock and the re-adjustment of stress and is characteristic of the rock type. The re-adjusting period is usually of short duration so that after 15 to 30 min. the micro-

seismic rate decreases to a value no greater than that preceding the blast.

Estimating stress and predicting failure from micro-seismic data would be difficult if it were not for the fact that the micro-seismic rate increases substantially with increases of stress. These increases usually cease when mining operations are stopped. However, for stress conditions that indicate failure micro-seismic rates in excess of 100 per min. are common. These high rates usually precede failure long enough (from 24 hr. to several weeks) adequately to warn the workmen. Sometimes a high rate may be detected for a period without being followed by failure; again, sporadic occurrence of high micro-seismic production may persist, sometimes for several weeks, before failure occurs. In any event any area that has produced high micro-seismic rates must be considered relatively unstable.

When the micro-seismic method is used to determine the structural stability of underground openings the operator should have some understanding of the state of stress and the area of maximum stress concentration that would exist in an ideal structure—that is, one composed of homogeneous and isotropic rock. Information on this subject can be obtained from stress theory and/or model studies. Usually geophones are planted in areas of high stress concentration so that the first indication of stress load can be detected. Also, if areas of instability are detected at points other than those indicated by theory or model studies, the cause should be investigated.

If structural studies are to be made over large areas and for extended periods geophones should be installed for the duration of the tests at a number of points within the area. The spacing of the geophones depends primarily on the seismic conductivity of the rock. Some information on the seismic conductivity of a given rock type can be obtained from " hammer blow " tests. For rock of good conductivity a light blow with a 1-lb. hammer can be picked up by a geophone at distances of 500 ft. to 1,000 ft., but both the hammer blow and the geophone must be on " solid " rock. For rock of this quality (which would include most of the rocks that will open stope) geophones are usually spaced on 100-ft. to 200-ft. centres.

Most mining operations—such as, drilling, blasting, mucking, tramming, hoisting, and pumping —produce seismic disturbances that are picked up and recorded with the micro-seismic equipment. These man-made disturbances complicate, if not obscure, interpretation of normal micro-seismic records. In general, records must be made when the mine is not operating—that is, between shifts or off shift. Some minimum disturbances, such as distant pumping or hoisting, can be tolerated because the seismic records therefrom are usually periodic and uniform in amplitude, whereas the micro-seismic records are always random both in time and amplitude. For the detection of small-scale stress areas, such as loose rock, several recording periods or listening tests are made daily. For structural studies a 1-hr. or 2-hr. recording period is sufficient to evaluate day-to-day changes.

Roof Control

The removal of small pieces of partly detatched rock, usually termed " loose," by barring, trimming, or scaling is a common practice in all underground mines. Larger sections of rock are usually shot down or supported with stulls or props if they are considered unsafe, However, the degree of safety of a suspected area is usually based on personal judgment and, as the size of the area increases, the decision to leave, remove, or support becomes correspondingly more difficult. During the past 15 years the micro-seismic method has been employed in a number of mines to detect loose. In most instances these roof-control investigations have been made in connexion with more general structural studies.

Roof control was studied for approximately a year in the Zinc Mines Works, Tennessee Coal and Iron Division, United States Steel Corp., Jefferson City, Tenn. This zinc mine is made up of large lenticular deposits which occur in comparatively massive limestones and dolomites. The deposit is mined by open stoping with random pillars. The roof rocks are usually limestone or dolomite. A number of geophones were placed in the roof of a large stope to ascertain the effect on the general stability of roof arch as pillars were removed. During the course of this investigation it was noted that the geophones in the roof were sensitive to local areas of disturbance. An inspection of the roof disclosed loose areas which, when removed, caused the micro-seismic activity to decrease notably. This practice was ultimately developed into a routine roof-control procedure. To improve the control, the roof trimmer and his helper became familiar with the operation of the micro-seismic equipment to the extent that, before the start of the shift and during the lunch-hour period when drilling and other machinery was not operating, the helper would listen to the response from the various geophones in the roof. When micro-seismic activity was noted the roof trimmer would bar down the area until the section of rock causing the activity was located and removed.

A micro-seismic investigation was conducted for a period of approximately 1½ years in the Old Bed mine (Clonan workings), Republic Steel Corp., Mineville, N.Y. The principal objective of this investigation was to determine the stability of the roof arch overlying an area from which pillars were being removed. Incidental to the main objective of this investigation sections of loose rock in the roof and pillars were detected and localized before failure.

The Clonan workings lie in a large anomalous fold which forms a complete loop. The ore is virtually pure magnetite. The roof rock is a granitic gneiss which is separated from the ore by a sharp contact. The area was mined by open stoping with random pillars. The stope height was over 100 ft. in the area in which this test was performed. Geophones were installed at fixed positions in the roof and side walls of the stope adjacent to a large pillar which was in the process of being removed. Daily micro-seismic observations showed that the average micro-seismic rate was approximately 8 micro-seismims per hour. This is the so-called background rate. The removal of pillar ore and other mining in the area did not change this rate, indicating that the general stability of the arch over the stope and the stress over the roof arch and side walls was unaffected by this mining.

Approximately 4 months after this investigation was begun the micro-seismic rate in one of the roof geophones jumped from an average of 8 per hr. to over 1,800 per hr., an increase of over two-hundred-fold. Sometime within the next 12 hours a 4-ton slab fell from the roof. The other geophones in this stope

were unaffected by this small disturbance. Both the degree of localization and the magnitude of the increase in the micro-seismic rate are characteristic of roof falls of this size.

The second period of increased micro-seismic activity was recorded approximately 7 months after initiation of this project. This activity was picked up by a geophone in the side wall but was not picked up by geophones in the roof. The cause of the disturbance was found to originate in a large fractured portion of a pillar which had been recently cut free from the roof. Five days after this period of activity began a fall of 3 tons occurred and 6 days later a 200-ton slab dropped from the side of the pillar.

The micro-seismic rate varied erratically during this period. From July 12 to 20 the rate rose from 8 to over 2,000 per hour, where it remained until July 22, when a small fall occurred. It dropped to less than 200 on July 23 and 24 and then rose to the 2,000 range again on July 25, 26, and 27. On July 28 the rate dropped to 540 per hour, although no fall preceded the decline; on July 29 it returned to the 2,000 range and the large fall occurred. However, the rate continued to increase on July 30 (to 2,640 per hour) and then dropped rapidly and did not rise again during the remainder of the investigation. This erratic behaviour is quite characteristic of local areas of stress; in fact it has been found that in local zones the micro-seismic rate often would rise to a comparatively high level and fall without any visible evidence of failure. However, this cycle usually recurs until there is some type of failure, followed by a short period of re-adjustment during which the micro-seismic rate decreases (sometimes in an erratic manner) until the stresses have become equalized and the micro-seismic rate returns to its background level.

Similar roof-control investigations have been made in a hard iron-ore mine in northern Michigan in both jasper and argillaceous shale roof; in a number of mines in the Tri-State zinc district, in chert breccia and limestone roof, and in the Oil-Shale mine, Rifle, Colo., in marlstone roof. All these investigations supplemented more general studies of the mine structure. In most instances both recording and aural testing were employed. Loose sections of roof ranging from less than 1 ton to over 250 tons were detected before failure.

Geology of the Bancroft Area

(*Concluded from the February issue, p. 121*)

The uranium mineralization, as represented by crystals of uraninite, uranothorite, and betafite in the veins, is believed to have taken place at an early stage in the crystallization of the vein material. Uraninite has been found (Nu-Age) frozen to the syenite wall rock and also scattered throughout the vein material. Although uraninite is often more abundant in the sheared or mylonite border zones its occurrence is thought to be unrelated to the shearing, it being a border-zone mineral. Uranothorite is especially abundant at the immediate contact between vein and syenite (red) at Nu-Age. Biotite appears to be important in the precipitation of the uraniferous minerals, since uraninite is often found adjacent to clusters of biotite in the vein material (Cardiff Uranium), betafite occurs with clusters of biotite (Halo) (Silver Crater), and uranothorite is quite common in narrow biotite veins (Nu-Age). In the Silver Crater calcite body betafite, besides being closely associated with lineally-arranged biotite books, also appears to follow a fracture system parallel to the gneissic structure of the wall rock.

The source of the calcite in the calcite-fluorite-apatite veins and in the calcite-apatite-biotite body (Silver Crater) has been discussed by others.

Calcite occurrences in the Bancroft area associated with radioactive mineral occurrences are assumed to represent remobilized marble inclusions or the calcite left over after the formation of pyroxene from the assimilation of limy sediments (amphibolite of the paragneiss-amphibolite group). Salmon-pink calcite forms patches, up to several feet across, in metamorphic pyroxenite or occurs as bands replacing zones in silicated marble. The intensity of the salmon-pink coloration is roughly proportional to the radioactivity. This calcite appears to be hydrothermal, but is believed to be derived from limy sediments—such as, calcareous amphibolite or marble—by the remobilization of these rocks by fluorine-bearing mineralizers.

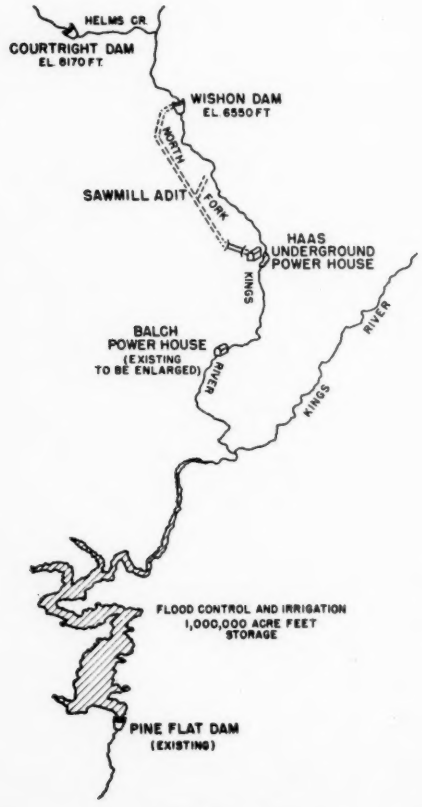
At the Canadian All Metals property metasomatic zones in silicated marble are radioactive and at places in these zones coarse calcite patches with large apatite crystals are found. It is assumed these patches represent recrystallized calcite marble with the addition of apatite. At the Cardiff Uranium property on the adit level a transition zone lying between chondrodite marble and calcite-fluorite-apatite-diopside-biotite vein material consists of a coarse white calcite with scattered large crystals of apatite and biotite. This material has the appearance of a marble acted on by mineralizers. This occurrence is very similar to that at the Silver Crater (Basin) property where a betafite-bearing calcite-apatite-biotite body is sheathed in an altered amphibolite containing calcite and fluorite (purple). The feldspar of the amphibolite is changed from oligoclase to albite owing to soda metasomatism. It is thought this body represents a remobilized mass of calcite marble or calcite derived from limy sediments by the action of fluorine-bearing solutions or vapours.

The calcite-fluorite-apatite veins occupy fissures in a variety of rock types. In many places the vein stage was preceded by a pegmatitic stage (Fission) (Halo) (Nu-Age), but at others the origin may be by replacement of a single horizon—such as, a silicated marble band (Cardiff Uranium). The vein material represents the remobilization of marble through the action of fluorine mineralizers as the end phase of a complex magmatic sequence of intrusives and replacement bodies of syenitic and granitic composition.

A Hydro-Electric Project in California

An account of progress on the Kings River project in California, the cost of which is estimated at $80,000,000, has recently become available. It is situated high up in the Sierra Nevada Mountains and will increase the present hydro-electric output of the region by 261,500 kW. It is being carried out for the Pacific Gas and Electric Company and the work comprises four stages :—(1) The Haas underground powerhouse ; (2) the Haas tunnel ; (3) the Wishon dam, and (4) The Courtright dam, the relation of which are indicated in the accompanying figure. It is stated that to date there are only approximately 100 underground powerhouses throughout the world, though they are common in Sweden, where underground drilling has been perfected to a high degree, and, in fact, the Haas underground powerhouse is described as the first "modern" underground project in the United States since 1913.

Future construction includes the installation of two new generating units in the existing Balch powerhouse, which will increase its capacity to 126,000 kW, the New Kings River tunnel having a 13-ft. horseshoe section, 18,450 ft. long, and the New Kings River powerhouse with a 42,000 kW capacity. The scope of the article available is confined to construction methods for the Haas underground powerhouse and the Haas tunnel section.



Location Plan.

The Courtright dam, which is now approximately 40% completed, is on the Helms Creek tributary and will be a 1,500,000 cu. yd. concrete-faced rock-filled dam with a maximum height of 304 ft. and a length of 850 ft., situated at an altitude of 8,174 ft. The powerhouse is at an altitude of 4,090 ft. above sea-level, 500 ft. below the surface of the ground, and 1,965 ft. back from the Kings River in a solid granite formation. The decision to build the powerhouse underground was taken for two main reasons, it is stated : First, an additional 2,000 ft. of penstock would have been required for a surface powerhouse and, secondly, the revenue for the life expectancy of the project was increased by using the power developed from the extra 3 ft. of water head. When completed the powerhouse will have a capacity of 128,000 kW. Work commenced on November 19, 1956, with a single shift driving the 8-ft. horseshoe tailrace. Approximately 17,000 cu. yd. of rock was excavated and the perfect rock formation permitted the tunnel to run unsupported for its full length of 1,963 ft. Towards the end of January, 1957, work had progressed far enough to warrant working on a three-shift basis.

The first step in excavating the powerhouse was the opening of a central floor level chamber, approximately 16 ft. wide, 70 ft. long, and 20 ft. high ; this was followed by driving the inverted Y penstock tunnels, a 51° incline manway to the extreme upper end of the arch, and two vertical rises to the dome, these operations being carried out simultaneously.

The next step was the opening up of an 8 ft. by 8 ft. drive the full length of the chamber dome, which intercepts the two vertical rises en route. The longitudinal drive was enlarged outwards and downwards to a point below the spring line, thus forming the entire chamber crown. Slushers were used to move the mucked material into the vertical rises, where it was subsequently removed by Eimco 105 muckers and 6-yd. Koehring Dumptors.

An unusual feature of the construction of the powerhouse was the use of the Swedish "Perfo" system of roof bolting, the first time this technique has been used on a major U.S. construction project. During this operation heavy drilling was suspended and the crews worked from a steel staging. The first step in the "Perfo" system was the drilling of approximately 1,200 bolt holes of 1½ in. diameter every 10 sq. ft. on 3½-ft. centres, the holes being drilled to a depth of 10 ft., 12 ft. 6 in., or 15 ft. Preformed and perforated cylindrical metal sleeves of 1¼ in. diameter were filled with grout, jointed, and then inserted into the bolt holes. Rods of 1 in. diameter were then driven into the mortar, their displacement forcing the material out through the perforations to form a bond the length of the bolt. Wire mesh was then suspended and some 15,000 sq. ft. of roof surface was given a 4 in. layer of Gunite. The excavation of the chamber was then carried on by benching down in stages. The final stage was the completion of the 755-ft. penstock shaft and the 389-ft. vertical access shaft, which was pilot drilled

to 6 ft. by 8 ft. and then enlarged to its final 18-ft. diameter.

Data on the completed underground powerhouse is as follows :—Chamber 173 ft. long by 56 ft. wide by 85 ft. to 100 ft. high ; a 9-ft. horseshoe penstock shaft 753 ft. long ; an 18-ft. tailrace tunnel 1,963 ft. long, and an 18-ft. access shaft 389 ft. deep.

By mid-July, 1957, excavation was approximately 85% completed against the contract termination date of September 1. The amount of rock excavated for the powerhouse chamber has been estimated at 30,000 cu. yd. The mucked material is shorthauled to a job-site crusher for crushing, screening, and stockpiling for future concrete work on this project. Included in the rock drilling equipment were Atlas Copco BBC-22 lightweight airleg drills which were used at various stages during the construction of the powerhouse, and standard Gardner-Denver and Ingersoll-Rand jack-hammers together with Atlas Copco airlegs, specially converted for sinking, required for benching operations during the chamber excavation.

The Haas tunnel which has a 13-ft. horseshoe section and is 6·2 miles long connects the Wishon dam with the Haas penstock and is being driven almost exclusively in granite and so far only a few soft spots have been encountered which required timbering. A 990-ft. access adit tunnel was driven at Sawmill Flats, approximately 3¾ miles down river from the Wishon dam. This dam will be a 3,690,000 cu. yd. concrete-faced rock-fill dam with a maximum height of 270 ft., 3,350 ft. long, and built at an altitude of 6,550 ft. ; work is now approximately 75% finished. The original project specifications provided for a possible second (Crabtree) adit which in all probability will not be opened owing to the excellent progress made to date.

Work on driving the main tunnel began on January 12, 1957, and by mid-July each heading had been driven beyond the 7,000-ft. mark. More than one-third of the major excavation work, therefore, has been completed in the initial six months on a contract not scheduled for completion until November, 1958. For the first eleven weeks tunnel driving was carried out on an alternate heading basis. Since mid-April, 1957, work has been carried out simultaneously on both headings. A remarkably consistent footage has been driven by the crews working on a three-shift six-day basis. The record for a single day's work was 142 ft. and the top week (in mid-July) was 834 ft. ; the weekly drilling totals have consistently topped 600 ft. As further evidence of the high degree of efficiency with which the " drill-blast-muck " cycle is conducted daily, from seven to nine rounds are fired every 24 hours.

Drilling in each heading has been carried out by six Gardner-Denver drifters, mounted on a job-fabricated two-deck jumbo, the drill steels are equipped with 1⅝ in. Sandvik Coromant detachable bits and with Brunner and Lay bits of the same size. A standard blast pattern with a centre burn and 9 ft. depth was drilled in most cases and approximately 40 cu. yd. of rock were obtained per shot. Conway type 100 muckers with 6-yd. side-dump cars haul the mucked material to a dump area near the adit.

Conditions in Hot Mines

An article in the *South African Mining and Engineering Journal* for February 7 reviews " Climate Control in Hot Mines " and suggests that satisfactory working conditions in such mines can be quite as effectively produced by the strict control of evaporation of moisture into intake air as by the use of expensive refrigeration plants.

As yet, it is stated, neither the physiological limit of human endurance nor the point at which poor environmental conditions impairs production have been established. Experience on South African gold mines has shown that even when the wet-bulb temperatures are in the 90's output is not seriously impaired. Heat-stroke cases can occur when the wet-bulb temperature is of the order of 84° F., but these are isolated instances and there is every reason to believe that the physiological limit of an acclimatized worker exceeds that figure by several degrees. Underground workers can maintain a satisfactory rate of production and suffer little physical discomfort at temperatures considerably in excess of those above which the installation of air-cooling plants is obligatory overseas.

The article goes on to say that the records of service of refrigeration plants which are now, or have been, operating on Witwatersrand mines and a comparison of the results obtained during ventilation observations in refrigerated and non-refrigerated shafts do little to support the contention that air-cooling plants are a necessity on present deep or hot mines. Further, from recent comparative observations at refrigerated and non-refrigerated shafts on the Witwatersrand and in the Orange Free State it is apparent that the difference between the temperatures recorded at comparable working faces distant from the shaft was generally small and of no practical significance, irrespective of the degree of surface cooling. For example, in a drive 8,700 ft. below surface in non-refrigerated Shaft A the temperature was found to be 95·0°–86·5° F. In a comparable drive at a depth of 8,400 ft. on refrigerated Shaft B the temperature was 90·0°–84·5° F. Temperatures recorded in stopes make the same point. In a stope on the 8,400-ft. level on Shaft A the temperature was 89·0°–88·5° F. ; while in a stope 7,000 ft. below the surface at refrigerated Shaft B the temperature was 89·0°–88·0° F.

The reason for the failure of refrigerated air to produce any appreciable improvement in ventilation conditions at working places far removed from the source of cooling results, it is said, from the fact that cooled air heats up far more readily than does unrefrigerated air. " Spot coolers "—small, moveable refrigeration units which are installed at the air intakes of ventilation " danger zones " produce an improvement in the temperature of the air in their immediate vicinity, but since the cooled air rapidly gains heat from the surrounding rock " oven " the conditions at the distant working faces served by the cooler may improve only fractionally.

It is considered difficult to offer any cut-and-dried figure for the cost of refrigeration, but it is a far from inexpensive process, says the article. The cost of installing a large plant capable of delivering air cooled to a degree or two above freezing-point may range from £200,000 to £500,000, depending upon

the capacity of the plant, and running costs may amount to one-tenth of the cost of installation each month. Moveable heat exchangers do tend to improve the "positional efficiency" of the cooling plants, but hot spots in stopes can exist and be aggravated by the usually limited supply of cooled air.

The physio-psychological effect of air cooling on underground workers must also be considered. Workers entering a hot mine in which the air is not cooled react rapidly to the hot conditions, sweating in order to lower their body temperatures. This makes them heat and ventilation conscious and under such conditions workers are likely to be more inclined to co-operate in matters relating to ventilation. In a hot mine with pre-cooled air, however, workers react less rapidly to underground conditions. The comparatively pleasant coolness at stations and intake airways tends to dull their awareness of the need to prevent the evaporation of underground water and of the necessity for ventilation control. Thus the effect of refrigeration may easily be nullified at hot working faces.

Several hot mines on the Witwatersrand and in the Orange Free State—notably Vlakfontein, Crown Mines, Robinson Deep, and Freddies Consolidated mines—have effectively proved that environmental temperatures at working faces can be quite as effectively controlled by the integration of factors of ventilation into mining layouts and by strict supervision of moisture evaporation in the intake airways as by the use of expensive cooling plants.

Vlakfontein is a well-known example of a hot non-refrigerated mine which, by means of rigid control of water evaporation into fresh air, has been successful in producing satisfactory ventilations at depth and in workings at a considerable distance from the ventilating shaft. Two neighbouring shafts at Crown Mines, Nos. 16 and 14, are an interesting and significant example of the relative effectiveness of air refrigeration. At the former shaft a surface cooling plant is installed, but at the latter uncooled air is delivered straight to the workings. However, even though one shaft is supplied with pre-cooled air and the other not conditions in comparable distant stopes at roughly equal depths and air distances differ to only a small degree. Freddies Consolidated Mines, in the Orange Free State, is another significant example of the improvement in underground conditions which can be achieved by taking into account ventilation requirements when designing the layout of workings and by the control of water evaporation in intake airways, which, of course, include shafts.

Experimental layouts on Freddies have shown that the length of airways and air distances play a relatively small part in the determination of air temperatures. Accordingly on this mine considerable emphasis is placed on the integration of mining and ventilation layouts and on the control of the ventilating air. Since 1953 the temperature gap in the North 2 Shaft has been improved from 1°–2° F. to the present 15°–20° F. Further, this mine applies the twin development system, which allows considerably more air to be circulated throughout the workings than do other development systems.

As the direct result of these measures the necessity for costly mechanical air cooling has been avoided and working places where wet-bulb temperatures of the order of 92·5° F. were previously recorded are now ventilated by air at 87·0° F., wet bulb.

What the virgin rock temperature of Western Deep Levels will be at the mine's ultimate depth remains to be seen, it is pointed out, but there is reason to believe that on the deeper levels of the mine it may be 5° F. lower than the rock temperatures encountered at depth on the Central Rand, on account of the thick capping of dolomite which overlies the Black Reef Series and Witwatersrand System on the West Wits. Line.

Western Deep Levels is still only in the first stages of its existence. There are no worked-out area in which air can be heated up or recirculated and it has the important advantage that ventilating air can be delivered direct to deep workings by a comparatively short route, which is not the case on the Central Rand. Consequently, although it is still too early to dogmatize on the subject, *prima facie* evidence suggests that the necessity for resorting to refrigeration plants may even here be avoided by integrating mining and ventilation layouts from the outset of development operations and by exercising strict control over the evaporation of moisture into intake air.

Trade Paragraphs

Instruments, Electronics, and Automation Exhibition.—This exhibition, which is held annually, is to take place at Olympia, London, from April 16 to 25 and, it is stated by the organizers, will be even bigger and better than the 1957 show and will contain an extensive international section.

Mechanical Handling Exhibition. This exhibition which is held every two years is to take place at Earls Court from May 7 to 17 and concurrently there is to be a Materials Handling Convention. Over 250 exhibitors from several countries are taking part and the equipment to be shown will include conveying, ropeways, earthmoving, and lifting tackle.

Knapp and Bates, Ltd., of 17, Christopher Street, London, E.C. 2 (telephone: Bishopsgate 9022), announce that they have moved to this address from Africa House, Kingsway.

D.P. Battery Co., Ltd., of Bakewell, Derbyshire, have produced a complete guide to their range of Kathanode batteries designed to suit every type of battery electric vehicle, truck, and locomotive.

Industrial Belt and Screen Co., Ltd., of 194–6, Finchley Road, London, N.W.3, which is an associate company of the Abisch Conveyor and Furnace Co., Ltd., announce that they are now making wire-mesh belts in this country. All types of belts of various materials are offered, it is stated.

Smail Sons and Co., Ltd., who represent H. Maiham AG, of Hamburg, and A. Ott, of Kempten, in this country, announce that their address is now 21–23, India Street, Glasgow, C. 2, where complete service and repair facilities will be available for pressure and vacuum gauges, thermometers, diesel injectors, engine indicators, etc.

Cinema-Television, Ltd., of Worsley Bridge Road, Lower Sydenham, London, S.E. 26, state that their name has now been changed to **Rank Cintel, Ltd.,** in accordance with the policy of the Rank group

of companies and to lay emphasis on the trading name of Cintel.

Joy-Sullivan, Ltd., of Cappielow, Greenock, Scotland, announce that following a re-organization programme at their Cappielow factory they have transferred all their spares activities to their premises at Dronfield, near Sheffield. All inquiries and requests for spares will now be dealt with by the newly-established spares department at Callywhite Lane, Dronfield (Telephone: Dronfield 2081, Telex.: 54/239).

Visco Engineering Co., Ltd., of Stafford Road, Croydon, have published a new edition of their illustrated booklet devoted to steel shell water coolers which have a number of industrial applications such as in the gas industry and diesel power plants. Mention is also made of "Sprayblast" oil coolers which is a modification designed to meet the needs of heat treatment plant for an efficient method of cooling quenching oils.

Consolidated Pneumatic Tool Co., Ltd., of 232, Dawes Road, London, S.W. 6, state that their rotary power vane compressors were chosen by the Sauda Falls Power Co. in Norway for operation at heights varying from sea-level to 5,000 ft. in dam construction work at a hydro-electric scheme. The compressors have been in operation for over one year and, apart from a change of rotor blades, have operated continuously during that time without the need for extra maintenance.

Head Wrightson Stockton Forge, Ltd., of Stockton-on-Tees, have produced an illustrated booklet on mine headgears and accessories. This points out that headgears are now mainly constructed of structural steel or reinforced concrete, timber being only used for small temporary structures. The booklet deals in particular with constructional features of headgears for pits or coal mines and covers winding sheaves, safety hooks, cages, Beien kep gear, and Bennett catch gear.

Lafarge Aluminous Cement Co., Ltd., of 73, Brook Street, London, W. 1, have produced a new 32-page booklet "Cement for Industry" which describes the properties and applications of Cement Fondu. This well-known quick-setting cement not only makes concrete in hours rather than days, it is stated, but can also be used for making corrosion-resisting concrete, refractory concrete (with refractory aggregates) up to 1,350° C., and insulating concrete (with insulating aggregates) up to 1,000° C.

Britannia Batteries, Ltd., of Redditch, have introduced a new fork tester, which enables a rapid reading to be taken of the state of charge of their tubular positive plate alkaline batteries. It enables the state of charge of a truck battery and the number of ampere-hours required to complete the recharge of the battery to be determined quickly by reference to a table of data supplied. Not only is the danger of undercharging eliminated but also excessive overcharging. The tester consists of a steel fork with a voltmeter and resistance attached. A pair of steel tongues are permanently fitted to the terminals of the pilot cell of Britannia batteries and the prongs of the fork are merely bridged across these tongues and the reading on the voltmeter compared with the data.

Halifax Tool Co., Ltd., of Southowram, Halifax, have lately added another model—the Mark III—to their range of Halco-Stenuick deep drilling machines, as illustrated. This is a blast-hole drill and is suitable for work at any angle from vertical to horizontal and up to 20° uphill by either percussive or rotary operation for hole diameters of either $3\frac{1}{8}$ in. or 4 in. A particular feature is the automatic power feed and pneumatic counterbalancing system by which the thrust can be preset to suit different drilling conditions. Other points to notice are: Independent and interchangeable rotation and winch motors both mounted on one unit, pneumatic clamp and centralizer to simplify tube

Halco-Stenuick Mark III Drilling Machine.

changing, and hydraulic elevation of mast and machine levelling.

George Cohen 600 Group, Ltd., of Wood Lane, London, W. 12, announce that a new 4-ton crane has been added to the range of Jones diesel mechanical models known as the KL 44B, it is a modification of the KL 44 in which advantage has been taken of the fact that the exceptionally high operating speeds of the KL 44, while important on such duties as grabbing, are not required by every operator needing a machine of this capacity. By modifying these operating speeds it has been possible to introduce a less powerful engine.

Communications Systems, Ltd., of Norfolk House, Norfolk Street, London, W.C. 2, draw attention to a new sound supervisory system and its application to winding ropes. At Rothes Colliery, Fifeshire, as part of the equipment for the tower-mounted winder plug-in points spaced between ground level and the top of the tower enable portable microphone-loudspeaker units to be inserted at any point when rope-changing operations are in progress. In addition coal flow through the preparation plant to the waiting wagons is also controlled by a similar system.

Dowty Hydraulic Units, Ltd., of Ashchurch, Glos., state that the latest addition to the Dowty range of industrial hydraulic components is a lock valve for use with Dowty "CV" series control valves. Available in a variety of sizes to match the control valve range, the lock valve isolates a ram or actuator from the hydraulic system and sustains it in the position selected. Both four-way and three-way valves are available and the four-way type can be readily converted to three-way if required. The lock valve can be mounted either directly on the control valve or in certain positions elsewhere in the system.

Chloride Batteries, Ltd., of Clifton Junction, near Manchester, in some notes on the problem of producing a battery with a consistently reliable performance at very low temperatures refer to their model 6WXA15ZR. The unique feature of this battery, which allows it to be externally heated as necessary, is its multi-compartment die-cast aluminium container lined with high-grade hard rubber. It can be heated by means of a hot-plate or hot air, or even put on top of an oil stove. The heating being controlled if desired by means of a thermostat attached to a special moulding in the centre cell connexion.

Quasi-Arc, Ltd., of Bilston, Staffs., have developed semi-automatic equipment for shielded inert gas welding. Known as the "Lynx" the equipment offers many new features, among which are: (*a*) A welding rectifier which is self-contained, having control of all the services required for the process. (*b*) A light and portable wire feed and control unit which the welder can readily reposition around large fabrications and which he can part into two assemblies for carrying over longer distances. (*c*) Motorized remote wire feed speed control. (*d*) A choice of water-cooled or air-cooled guns which are readily interchangeable without any modification of the equipment.

Rotary Hoes, Ltd., of West Horndon, Essex, announce that they are taking steps to increase the production of the new ten-ton all-steel ratchet lifting jack which they recently introduced as a companion to their five-ton model. Both jacks are marketed under the trade name "Equilift." The ten-ton jack is factory tested to 12½ tons, its overall height when closed is 16 in. and when raised 25¼ in. Equal lift is obtainable from both head and foot and height of the foot when closed is 1½ in. and when raised 11 in. By comparison the five-ton is tested to 6½ tons and has an overall height of 16 in. when closed. Its range of lift is 9½ in., giving it an overall height of 25 in. when raised.

Megator Pumps and Compressors, Ltd., of 43, Berkeley Square, London, W. 1, have introduced a new compact, portable, face drainage unit, specially designed to deal with small amounts of "nuisance water" underground. Known as the Megator puddle pump, the unit consists of a small version of the standard Megator M50 pump powered by a continuously-rated, flameproof, mining-type motor wound for 110 volts, three phase, 50 cycles. The pump will handle eight gallons a minute with a total head from all causes of 100 ft. The complete set is mounted on a mining-type base fitted with lifting handles. A further feature of the new pump is that it gives interchangeability of spares with the M8 dust-suppression pump which is now widely used.

Michigan (Great Britain), Ltd., of 3–5, Charles II Street, St. James's Square, London, S.W. 1, issue the following statement: Clark Equipment International with their British associates All Wheel Drive, Ltd., announce the completion of arrangements for the manufacture of Michigan earth moving and materials handling equipment in the United Kingdom. Production of the 75A and 175A tractor shovels has been commenced and these models are now available for sterling. The company's products include tractor shovels, dozers, scrapers, and loggers and in each series the machines utilize the same engines, transmissions, torque converters, and planetary wheel axles, providing interchangeability of components. Works and service is located at Yorktown Works, Camberley, Surrey.

Mack Trucks, Inc., of Plainfield, New Jersey, have received an order from the Alcoa Exploration Co., a subsidiary operating in the Dominican Republic of the Aluminum Company of America, for what is believed to be the largest aluminium dump truck yet made. It has a capacity of 37½ cu. yd. and weighs 27 tons. A special feature of the truck is the heating of the floor by engine exhaust gases to facilitate the dumping of moist bauxite. It is understood that Alcoa is to spend $10,000,000 on developing the bauxite deposits in the Republic, estimated at 60 million tons with an aluminium content of 45% to 50% and that the Dominican Government is to co-operate with the company in converting the harbour of Enriquillo into a deep-water port for shipping the ore. Plans are under way, it is stated, for the construction of a government-financed aluminium reduction plant which when in operation will buy 850,000 tons of ore annually from Alcoa.

Davies Magnet Works, Ltd., of Ware, Herts., have produced a new descriptive leaflet devoted to their Model 51 magnetic separator of high capacity and non-entraining. Some features of the machine are: Knife edge precision separations of even most feebly magnetic minerals. Complete elimination of entrainment by use of patented pick-up rings, with no banking of partially attracted particles and cleaner discharge products. Infinitely controlled electrically-operated vibrating feeders of hard stainless-steel construction to withstand mineral abrasions.

Agitated incoming feed is never static so the magnetic particles are not blanketed by non-magnetics, giving unhampered lift by extracting magnets. Direct coupled geared motor drive and built-in rectifiers for magnet energization with accurate rheostat control. Minerals that can be treated include ilmenite, bauxite, magnesite, manganese, feldspars, wolframite, rutile, garnet, tantalite, molybdenite, diamond sands, chromite, monazite, and colombite.

British Thomson-Houston Co., Ltd., of Rugby, in a recent announcement refer to the first sinking winders in Great Britain to be tower-mounted. They state that the company, as main contractor, has received a large order from the National Coal Board, North-Eastern Division, for four mine winder equipments and associated plant to be installed at a new colliery at Kellingley, North Yorkshire. Delivery is due to commence before the end of 1959. The winders will be of the friction type. The adoption of the tower-mounted winder at the start has the advantage that the temporary headgear and special winders usually employed for sinking the shafts will not be necessary, for when sinking operations have been completed only a comparatively simple modification will be required to change from single-rope working to the full four-rope friction winder arrangement. There will be two shafts (upcast and downcast) at this colliery and two winders will be employed in each shaft. The downcast winders, which will incorporate cages and counterweights and will normally carry men and materials, will each be driven by a 1,100-h.p. 11,000-volt slipring induction motor with reduction gearing. Fully-automatic control will be provided. The dynamic braking equipment will include germanium power rectifiers and power magnestats. The two upcast shaft winders, which will be used for coal raising, will incorporate skips and counterweights and will in this case each be driven by two 1,100-h.p. slipring induction motors with common gearing. Again dynamic braking equipment and a fully-automatic control system will be provided. A total of seven identical winder motors will be supplied, six to be installed for the winders described and one to be supplied as standby plant. The mechanical parts for the winders will be supplied by **M. B. Wild and Co., Ltd.,** of Birmingham.

Metropolitan-Vickers in 1957

The January issue of their *Gazette* is entirely devoted by the Metropolitan-Vickers Electrical Co., Ltd., of Trafford Park, Manchester, to a review of work and progress in 1957. Some extracts follow :—

Electric Winders.—Up to the present electric drives for mine winders have been predominantly either d.c. Ward-Leonard or a.c. three-phase (slipring motor). Last year, however, saw the recognition of the mercury-arc rectifier/invertor system. The successful operation of the prototype of this new control at Monk Bretton colliery (N.C.B.) has resulted in eleven further orders for rectifier equipments, including four of 2,500 h.p. for four-rope friction tower-mounted drives at Parkside and Agecroft collieries which will permit automatic and manual operation. In each case the rectifier system was compared economically with the Ward-Leonard and a.c. systems, taking into account the capital cost, interest, and running cost. A clear economic advantage was evident with the use of mercury-arc rectifiers. During the year, at Rothes colliery, two tower-mounted single-rope friction-drive winders were commissioned. These winders, rated at 3,780 h.p., are the largest friction-drive tower-mounted winders in the country. The control system is Ward-Leonard employing closed-loop control with metadyne amplifiers. At the Rufford colliery (N.C.B.) a winder was erected employing the four-rope friction-drive principle. During the year an a.c. manual closed-loop control system was developed and a 1,350-h.p. a.c. winder was successfully commissioned at West Cannock No. 5 colliery (N.C.B.). With the increase in electrical load on colliery supply systems it has become economic to use higher voltages on the driving motors for large a.c. winders. During the year a number of orders for 6·6 and 11-kV a.c. winders were received, including a 1,950-h.p. a.c. winder for the N.C.B. Sharlston colliery, Yorkshire, with the motor wound for 11 kV.

Among orders for overseas was one from African Associated Mines (Pvt), Ltd., for an automatic a.c. winder for the Shabani shaft, which will be of 1,200 h.p., with the same automatic a.c. control already in successful use in the automatic a.c. winders installed in the Newcastle and Cumberland Division of N.C.B. During the year two Aspinall mine winder signal recorders were installed at Bestwood colliery. This instrument is specially designed to record continuously on moving tape all the signals passed between the winder driver and the other operators and also the time of the signals.

Mine Electrification.—Four 850-h.p. 6·6-kV flame-proof type KF squirrel-cage motors were supplied through **Harland Engineering Co., Ltd.,** for driving main unwatering pumps for the new Cynheidre colliery, South Wales. A motor-driven compressor went into service at Maltby colliery. Orders received include a contract from N.C.B. for 90-h.p. flame-proof motors specially developed to drive Armstrong air breakers. These are six-stage air-compressors used an an alternative to explosives for breaking coal off the face ; bulk ordering is now following from successful experiments at various collieries. This is the first contract M-V has received from this new department. For overseas M-V have supplied through **Davey, Paxman and Co., Ltd.,** six 147-kVA type RF synchronous generators, switchgear, and automatic voltage regulators for diesel-electric equipment being supplied by **Orenstein and Koppel** of Germany for Consolidated Diamond Mines of South-West Africa, Ltd. An order for two further sets has followed. Other export orders include six 700-h.p. type RW slipring motors and control gear for ore crushing equipment at Mount Isa Mines, Queensland, from **Victor Products (Wallsend) Ltd.,** for 360 stator and rotor units for 150-c/s coal drilling units for Poland and from **Beckett and Anderson** for ten 30-h.p. type RW slipring motors, switchgear, and control gear for additional haulage drives for underground duty at the Singareni collieries at Hyderabad, India.

Oil Drilling.—Work is nearing completion on the equipments for two diesel-electric oil-drilling barges for Shell, designated GP 9 and GP 10, for operation 25 miles off-shore on Lake Maracaibo, Venezuela. These two rigs, which have a larger electrical capacity than that of barges supplied previously, are designed for drilling 18,000 ft. below the lake bed. Shell also require 100-h.p. squirrel-cage motors (type RKSP) for pumping duty at block gathering stations (storage tanks) to be associated with the oil drilling operations at Lake Maracaibo. The Kuwait Oil

Company have placed a direct order for an 850-h.p. main booster pump motor for one of the gathering stations in the Kuwait oilfields. The motor drives the pump through a fire wall which protects the machine from dangerous gases.

Electric Drives. A.C. Machines.—Large a.c. motors completed are a 3,000-h.p. 490-r.p.m. 11-kV "AIF" winder drive for Manton colliery and a 2,600-h.p. 493-r.p.m., 6·6-kV "AIF" winder drive for the New Consolidated Gold Fields at Doornfontein. Two 1,250-h.p. 150-r.p.m. 3·3-kV AIS synchronous induction motors for driving ball-mills in Rhodesia have a high starting torque with a low starting current and are arranged to run at unity power factor.

D.C. Machines.—Among the machines dispatched this year were the main winder motors and the motor-generator sets for Cynheidre and Abernant collieries of the N.C.B. The winder motors for Cynheidre are two 1,350-h.p. 400-V 636-r.p.m. machines supplied from a 1,900-kW 400-V 600-r.p.m. generator; those for Abernant are two 2,000-h.p. 675-V 600-r.p.m. motors and one 1,500-h.p. 675-V 700-r.p.m. machine supplied from three 1,400-kW 675-V 750-r.p.m. generators. A 3,100-h.p. 720-V 72-r.p.m. winder motor and its generator, a 2,300-kW 720-V 490-r.p.m. machine, were dispatched to Welkom Gold Mining Co. of the Anglo American Corporation. These machines are duplicates of many others previously supplied to South Africa.

There were numerous orders received during the year for d.c. motors and generators for winders including the Bevercotes and Grimethorpe collieries of the N.C.B. Winder motors are in hand for Peckfield, Silverhill, Ellistown, Parkside, and Agecroft collieries of the N.C.B. where mercury-arc rectifier/invertor winders are being installed. Orders for overseas include a 1,000-h.p. 600-V 574-r.p.m. winder motor for the Great Boulder Gold Mines, Australia. Work is proceeding on the five exciters, each of 364-kW output at 360 V 166 r.p.m., for Kariba power station (Federation of Rhodesia and Nyasaland).

Switchgear.—One of the more interesting orders received for vertically isolated type VH switchgear is that received from the Selection Trust for the Mufulira west copper mine, which includes 29 11-kV 350-MVA type V22H units with compound-filled double busbars. The units will be arranged in "U" formation to provide maximum visibility for instruments and meters. Also for the Selection Trust are a 13-panel, 11-kV 250-MVA type V1H2R switchboard for equipping a new smelter substation and 25 3·3-kV 150-MVA type V1H2R units for supply control to a new shaft—both for the Roan Antelope copper mine.

RECENT PATENTS PUBLISHED

☛A copy of the specification of the patents mentioned in this column can be obtained by sending 2s. 8d. to the Patent Office, Southampton Buildings, Chancery Lane, London, W.C. 2, with a note of the number and year of the patent.

3,648 of 1954 (789,962). F. L. SMIDTH AND CO. AB. Burning of cement, ores, and the like.

17,685 of 1955 (790,652). HARDINGE CO., INC. Comminuting and classifying apparatus and method.

22,733 of 1955 (790,868). MONTECATINI SOC. GEN. PER L'INDUSTRIA MINERARI E CHIMICA. Production of titanium or like metal sponge.

26,003 of 1955 (789,899). HARDINGE CO., INC. Pulverizing mill and process of pulverizing material.

28,855 of 1955 (789,700). R. TAKAHASHI. Method for chemically pulverizing solid material.

224 of 1956 (790,032). METALLGESELLSCHAFT A.-G. Method of carrying out endothermic reactions on a band sintering machine.

9,123 of 1956 (790,092). KLÖCKNER-HUMBOLDT-DEUTZ A.-G. Impact crusher.

14,957 of 1956 (790,970). KAISER ALUMINUM AND CHEMICAL CORPORATION. Process for treating aluminous ores.

16,235 of 1956 (790,738). KLÖCKNER-HÜTTENWERK HASPE A.-G. Preparation of fine and superfine ores and dusts for sintering.

20,432 of 1956 (790,188). E. I. DU PONT DE NEMOURS AND CO. Production of refractory metals.

NEW BOOKS, PAMPHLETS, ETC.

☛Publications referred to under this heading can be obtained through the Technical Bookshop of *The Mining Magazine*, 482, Salisbury House, London, E.C. 2.

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Selected Index to Current Literature

This section of the Mining Digest is intended to provide a systematic classification of a wide range of articles appearing in the contemporary technical Press, grouped under heads likely to appeal to the specialist.

* Article in the present issue of the MAGAZINE. † Article digested in the MAGAZINE.

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